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ECOLOGICAL RESTORATION PLAN FOR THE MOUNT HAGGIN INJURED AREA

January 2002

Submitted to:

Montana Department of Justice
Natural Resource Damage Program
Helena, Montana

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ABBREVIATIONS AND ACRONYMS

AERL	ARCO Environmental Remediation, LLC
ARCO	Atlantic Richfield Company
ARTS	Anaconda Revegetation Treatability Study
ARWWS	Anaconda Regional Water, Waste and Soils
AUDB	Agency Upland Design Basis
BA	Bare Area
BMP	Best Management Practice
BRI	Bitterroot Restoration, Inc.
COC	Contaminant of Concern
DEQ	Department of Environmental Quality
DG	Degraded Grasslands
EPA	Environmental Protection Agency
GIS	Geographic Information System
GPS	Global Positioning System
IA	Injured Area
IG	Impacted Grasslands
LRES	Land Reclamation Evaluation System
MSU-RRU	Montana State University-Reclamation Research Unit
M WV	Monitor Well Vegetated
NA	No Action
NRIS	Montana Natural Resource Information System
NRPD	Montana Department of Justice Natural Resource Damage Program
PR	Previously Reclaimed
PTSG	Planting of Trees, Shrubs and Grasses
RA	Reference Area
RDU	Remedial Design Unit
ROD	Record of Decision
SDG	Steep Degraded Grasslands
SG	Steep Grasslands
SH	Smelter Hill
SR	Stucky Ridge
SSR	Steep Slope Reclamation
T	Tillage
USGS	U.S. Geological Survey
VI	Vegetation Improvement
WMA	Wildlife Management Area
WV	Well Vegetated

SECTION 1

INTRODUCTION

Section 1: Introduction

Natural resources of the Mount Haggin Wildlife Management Area, hereafter referred to as the Injured Area (IA), including soils, vegetation, wildlife habitat, and wildlife, have been injured as a result of historical and continuing releases of hazardous substances from the mineral processing operations at the Anaconda Smelter. The Terrestrial Resources Injury Assessment Report Upper Clark Fork River NPL Sites ("Terrestrial Injury Report") issued in 1995 states that the loss of a diverse and healthy plant community has resulted in the loss of viable wildlife populations typical of a southwest Montana upland habitat (Montana 1995). Restoration of a desirable native plant community is a key element for mitigating impacts to natural resources within this area. The purpose of this restoration plan is to examine alternative methods for site restoration, present a strategy for implementing restoration activities, and to provide cost estimates for ecological restoration of the IA.

The Montana Department of Justice, Natural Resource Damage Program (NRDP) proposes to assess natural resource damages of the IA through the development of a comprehensive ecological restoration plan. Restoration will focus on the re-establishment of a diverse native plant community and consist of the planting of trees, shrubs, grasses, and forbs on contaminated areas. Benefits to be derived from implementation of such a program will include:

- Restoration of cover and forage for large-game mammals that are currently transient visitors to the site (elk, black bear, others).
- Restoration of habitat suitable for non-game species absent from the IA due to metals contamination.
- Improved water quality in the associated drainages and waterways.
- Improved aesthetics and recreation opportunities for hunters, hikers, and others users of the site.

1.1 Goal Statement & Objectives of Ecological Restoration

1.1.1 Goal Statement

The Mount Haggin IA Restoration Plan will identify measures to mitigate wildlife habitat loss resulting from hazardous substance contamination through the restoration of native vegetation.

1.1.2 Objectives

1. Convert areas that are presently metals impacted grasslands or devoid of vegetation into grasslands, shrub lands, or conifer forests with plant species composition and structural diversity comparable to baseline conditions.
2. Control erosion on degraded areas and consequently improve water quality and fisheries on associated waterways.
3. Minimize weed invasion onto barren and degraded areas throughout the site.
4. Eliminate visual blemishes (i.e.- barren, eroding soils) on the IA landscape.

1.2 The Concept of Restoration

Restoration Ecology is an applied science concerned with renewing and maintaining ecosystem health (SER 1995). The U.S. National Research Council (1992) broadly defines restoration as follows:

> *Restoration is defined as the return of an ecosystem to a close approximation of its condition prior to disturbance. In restoration, ecological damage to the resource is repaired. Both the structure and the functions of the ecosystem are recreated. Merely recreating the form without the functions, or the functions in an artificial configuration bearing little resemblance to a natural resource, does not constitute restoration. The goal is to emulate a natural, functioning, self-regulating system that is integrated with the ecological landscape in which it occurs. Often, natural resource restoration requires one of the following processes: reconstruction of antecedent physical hydrological and morphological conditions; chemical cleanup or adjustment of the environment; and biological manipulation, including revegetation and the reintroduction of absent or currently nonviable native species.*

1.2.1 EPA Viewpoint

The Agency Upland Design Basis (AUDB) prepared by EPA's remedial contractor, Montana State University-Reclamation Research Unit (MSU-RRU), defines restoration in a more precise manner and recognizes the specific relationship between restoration, remedy, and the Record of Decision (ROD) (EPA 2001). Remedial actions are proposed for a small portion of Mount Haggin (52 acres) while the preponderance of the site will be allowed to recover naturally if possible (AERL 2001). The Land Reclamation Evaluation System (LRES) has not evaluated the greater area of the IA, however, and the concepts of remedy and restoration may apply to the entire IA. The AUDB provides the following specific criteria to achieve restoration of the remedy area (p.23-24):

- *Vegetation quality exceeds remedy both in canopy coverage (>45%) and in diversity (>>5 species/100m^2).*
- *Vegetation quality is minimally dependent on contaminants of concerns (COC) levels and strongly controlled by physical characteristics of the soil.*
- *Many species can grow in the soil including those native to the area prior to disturbance.*
- *Plant succession is possible in short periods of time (<20 years).*
- *Vegetation will be dominated by native, forbs, grasses, shrubs, and trees much like the pre-disturbance plant community.*
- *Metals tolerant species are unimportant in the plant community.*
- *Vegetation must be established that mirrors the pre-disturbance wildlife habitat both in species diversity and structural diversity.*

1.2.2 Bitterroot Restoration, Inc. Viewpoint

Bitterroot Restoration, Inc.'s (BRI) view of restoration takes into account the concept of effectiveness as described by Higgs (1977) and Lockwood and Pimm (1999). Effective restoration has been defined as containing three components: 1) structural/compositional replication; 2) functional success; and 3) durability (Higgs 1997; Lockwood and Pimm 1999).

Structural/Compositional Replication. Structural/compositional replication is described in terms of similarity of plant species diversity (richness and abundance) between the reference area and restored area.

The AUDB sets criteria in which vegetation would be controlled by soil characteristics and would "mirror pre-disturbance wildlife habitat both in species diversity and structural diversity." The LRES is a system that evaluates present field conditions and recommends a remedial action for a specific area. The LRES treatments proposed in the preliminary design package will result in a substantial reduction in the influence of metals on plant communities, but will only partially achieve the criteria of mirroring pre-disturbance wildlife habitat due to the limited nature of the revegetation plantings.

BRI recognizes the problematic nature of proposing to restore entire plant communities that "mirror pre-disturbance" conditions. This is referred to as the difference between "full" and "partial" restoration; full restoration being the re-introduction of the full compliment of species that originally inhabited a site while partial implies the re-introduction of a subset of species. The ability of any restoration to succeed in full restoration is questionable while achieving partial restoration of dominant or definitive species in the community is obtainable (Lockwood and Pimm 1999).

In order to produce an effective structural/compositional replication, proposed actions for restoration should emphasize the planting of the broadest spectrum of site-adapted native plant species representative of the original plant community. Plant species should represent all life forms (trees, shrubs, grasses, forbs, and non-vascular plants) and different reproductive strategies such as wind and insect pollinated species. Also, actions should be taken to modify the physical and chemical characteristics of damaged soils in order to develop soil characteristics capable of supporting these species.

Functional Success. Functional success of restoration is measured by the presence of ecosystem processes, such as forage productivity, soil erosion, and loss or retention of nutrients (Lockwood and Pimm 1999).

The criteria set by the AUDB are implicit with respect to function. It is assumed that a 45% cover of native plant species with greater than 5 species/100m^2 will result in adequate forage production, erosion control, and cycling of nutrients. The proposed LRES treatments will address these criteria to a point. For example, LRES will achieve erosion control on the site and provide for a limited level of forage through planting of trees, shrubs and grasses (PTSG). It is not clear, however, if the addition of nutrients will result in sustained productivity and if cycling of nutrients will occur in soils that are largely microbially inactive.

In order to produce an effective functional restoration, proposed actions for restoration should include the re-introduction of mycorrhizal fungi in order to promote the effective utilization and cycling of nutrients. The addition of organic matter and repeat fertilization should occur to develop adequate nutrient reserves and soil structure for sustained productivity. A program relying upon single applications of nutrients and which does not address soil structure will likely not result in a functional community as measured by productivity or long-term erosion control.

Durability. Durability is the ability of the restored plant community to resist invasion, avoid excessive levels of extinction and persist as succession will allow. Durability is influenced by natural phenomena such as drought and flooding and evidenced by reproduction of restored species. Restoration of a particular species composition that is not durable will be transitory and revert back to an unsuccessful state. Durability is generally measured through monitoring.

The criteria presented do not address the issue of durability. Although the word "sustainable" is utilized in the Preliminary Design Package to describe the proposed restoration plant community, the implication of durability is that the restored plant community would resist change. A criteria statement that identifies sustainability as the ability to "resist changes in species composition as influenced by drought, flooding, or weed seed presence" would be appropriate to describe restoration in terms of time.

In order to produce a durable restoration, proposed actions should emphasize the control and elimination of non-native weedy species and extended planting efforts in order to promote the successful re-introduction and expansion of species. Also, repeat fertilization and re-introduction of microbial organisms to improve soil characteristics as described in the functional restoration section contribute to durability.

1.3 Proposed Restoration Alternatives

BRI proposes three alternatives in order to achieve varying levels of restoration. Three separate alternatives have been developed which vary in intensity, length of time to baseline conditions, risk of continued site degradation, and cost. The alternatives considered are:

- No Action Alternative
- Site Stabilization Alternative
- Active Restoration Alternative

No Action Alternative. The goal of this alternative will be to allow sites as treated by remedy actions to follow a natural recovery trajectory. This alternative assumes that remedy actions are successfully completed. The No Action Alternative will rely entirely upon natural recovery and could result in extended time towards recovery, in a steady state consisting of the remedy revegetation effort, or a trajectory of site degradation with no or minimal recovery. This alternative recognizes the potential for remedy to succeed in partially restoring the potential ability of a site to recover naturally while accepting risks of failure or further degradation. This alternative will not actively pursue restoration and may not result in ecosystem health, richness of plant species, and diversity of structure similar to baseline.

Site Stabilization Restoration Alternative. The goal of the Site Stabilization Restoration Alternative will be to restore functional erosion control and initiate a trajectory of recovery of natural resources towards baseline. Components of this alternative include installation of physical erosion control measures, seeding, fertilizer application, possible lime application, and maintenance as necessary. Dominant species composition and structural diversity characteristic of baseline conditions are not of concern for this alternative. This alternative will rely heavily upon natural recovery and result in site stability and an extensive time for recovery of natural resources to baseline conditions.

Active Restoration Alternative. The goal of the Active Restoration Alternative will be to restore mid-successional plant communities and initiate a trajectory of recovery of natural resources towards baseline. Components of this alternative include enhancement plantings which provide 5 additional species to site richness (5 species @ 100 stems/species=500 stems/acre), application of amendments to plantings, initial fertilizer application, possible lime treatments on all areas, and maintenance as necessary. The focus of this alternative will be to increase species richness on sites. This alternative will rely heavily upon natural recovery, result in use by wildlife species adapted to edge communities, and an extensive time for recovery of natural resources to baseline conditions.

Alternatives are further contrasted in Section 5.

1.4 Restoration Planning Process

This restoration planning process was devised to provide a logical framework for identifying restoration needs and developing alternatives. The restoration planning process integrates in-field characterizations of site conditions with computer-based planning tools to allow for an effective and efficient means of quantifying restoration needs and costs for large areas. The process was designed to answer the following basic questions concerning restoration of the IA:

1. What species are appropriate to produce an effective restoration?

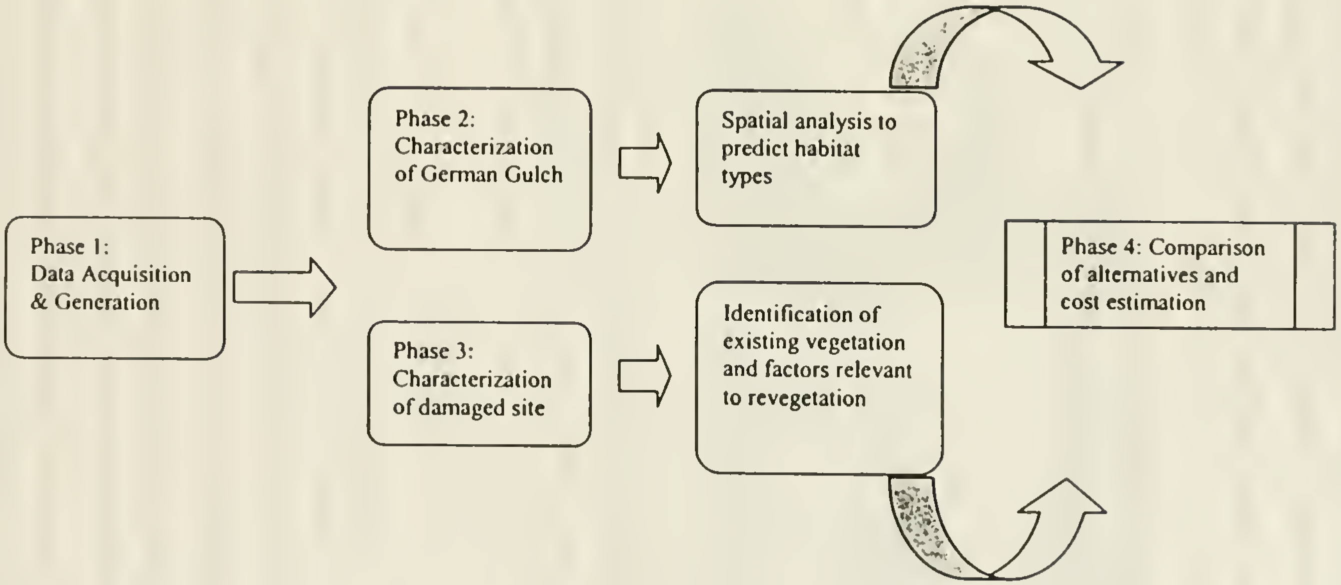
2. How should restoration species be distributed?

3. What are the methodologies and techniques necessary to overcome potential environmental and other obstacles on the site?

4. Are other alternative strategies available for achieving the same restoration goal?

Restoration Planning proceeded in four phases as described in **Figure 1.4.1**. During Phase 1, data were generated and acquired to support subsequent phases. Phase 2 characterized the German Gulch reference site utilizing Geographic Information System (GIS) technology and field evaluation in order to predict the natural vegetation of the IA. Phase 3 characterized current vegetation on the IA and identified factors that are relevant to revegetation. Phase 4 compared three alternative strategies for achieving restoration and quantified costs associated with restoration.

Figure 1.4.1. Planning Process Flow Chart



1.4.1 Phase 1: Data Acquisition & Generation

The purpose of Phase 1 was to identify and acquire spatial data sets for analysis of the German Gulch Reference Area (RA) and the IA. Data gaps were identified and data obtained for the IA and are described below in **Table 1.4.1.1**

Table 1.4.1.1. Spatial layers used in the analysis

Layer Description	**Source**
30 meter Digital Elevation Model (DEM)	USGS
Contours (5', 10', 50')	NRIS
Hydrography	NRIS (TIGER data)
Transportation	NRIS (TIGER data)
LRES subpolygons	ARCO/CDM
ARCO soil sampling points	ARCO/CDM
Injured area boundaries	NRIS
Land ownership	NRIS
Transect lines	Generated in-house
Transect points	Generated in-house
Aspect map	Derived from USGS DEM
Slope map	Derived from USGS DEM

GIS layers generated in-house (point and line transect layers) followed a predetermined protocol. These layers were used by field ecologists to study vegetation and habitat characteristics within the IA. Transects were drawn such that they covered the maximum elevation range and breadth of the IA.

1.4.2 Phase 2: Characterization of German Gulch Reference Area

The purpose of Phase 2 was to determine which plant species to restore to the IA. Phase 2 was accomplished by characterizing patterns of native vegetation on the RA and developing a model which would predict the locations of native vegetation on the IA. Field sites were visited within the German Gulch RA and specific native plant associates (or habitat types) were related to landscape features. In certain instances, existing data was utilized in lieu of field-collected data. The relationship between the landscape position (elevation, aspect) was evaluated and a model that predicts where native vegetation would occur was developed for the IA.

1.4.3 Phase 3: Characterization of Remedial Design Units

The purpose of Phase 3 was to determine whether specific techniques or methods would be necessary to insure the successful restoration of the IA. Phase 3 was accomplished by characterizing factors relevant to restoration at the IA. Specifically, an in-field evaluation of the IA categorized site conditions such as the prevalence of competing vegetation, presence of noxious weed species, and the intensity of browse by animals (**Table 1.4.3.1**). The data were evaluated and utilized during the development of treatments to determine whether or not to apply specific restoration techniques such as browse protection or weed control.

Table 1.4.3.1. Measured factors and potential responses.

Factor	Response (techniques or method)
Plant Competition	Scalping, Herbicide Application
Noxious Weed Presence	Weed Control Techniques (biocontrol)
Browse	Browse Deterrents (chemical repellants, physical browse protection)
Erosion	Erosion Control Measures (coir wattles, blankets, tackifiers)
Ground Cover (plantability)	Plan Modification (site preparation, alter plant specifications)
Microsite Presence	Microsite Ehancement (log additions, physical environmental protection)
Soil Fertility	Fertilization

1.4.4 Phase 4: Comparison of Restoration Alternatives

The purpose of Phase 4 is to compare alternative strategies for achieving restoration goals. The development of alternatives recognizes that LRES remedy actions may achieve adequate restoration potential on the limited acreage addressed by remedy on the IA, natural recovery may substitute for active restoration efforts in certain instances, and ecological or economic considerations may make active restoration efforts unfeasible. Three separate alternatives that vary in intensity, in cost, and in potential outcome were developed for each proposed remedial design unit (RDU) type. A comparison of alternatives, associated treatments, and cost on a per acre basis is included.

1.5 Mount Haggin Injured Area Restoration Plan

The restoration plan that results from the restoration planning process identifies the actions necessary to successfully restore wildlife habitat values associated with baseline conditions. The IA Restoration Plan is organized into the following sections:

- Section 1: Introduction. Goals, objectives and the planning process identified.
- Section 2: Project Setting. Identifies the general areas of interest, characteristics of the environment, and review of previous revegetation efforts and proposed LRES efforts.
- Section 3: Characterization of the German Gulch Reference Area. An analysis of the field study, GIS spatial analysis, and proposed habitat suitability model for the IA.
- Section 4: Characterization of the Injured Area. Present model of the IA with acreage of individual treatment types, predicted vegetation based upon RA with acreage, and present the evaluation of factors that may effect revegetation efforts.
- Section 5: Comparison of Alternatives. Review of alternatives with treatment matrix, prescriptions, potential effectiveness, potential impacts, and estimated costs.
- Section 6: Restoration Treatments and Specifications. Specifications to be used for the restoration alternatives are described.
- Section 7: Descriptions of Restoration Species. Plant materials with their associated wildlife and erosion control values are described.
- Section 8: Cost Estimate for Restoration. All costs associated with implementation of the restoration plan are identified.

All plant names listed within the text are common names with Latin names located in Appendix A.

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SECTION 2

PROJECT SETTING

Section 2: Project Setting

2.1 Area Of Interest

The Mount Haggin Wildlife Management Area (WMA) encompasses a total of 56,151 acres in Deer Lodge and Silver Bow Counties south of Anaconda, Montana. Of interest to this project are two specific areas west of the Continental Divide within the Mount Haggin WMA, IA and the RA(**Figure 2.1.1: Area of Interest**).

The IA consists of a 4,091-acre site[1] that has been impacted by deposition of metals and arsenic emitted from the Anaconda Smelter. The IA is bounded on the west by Mill Creek Highway, on the south by the Continental Divide, and the upper watersheds of three major drainages into Mill Creek on the east. The north boundary is the Cabbage Gulch drainage.

The RA is identified as the German Gulch Portion of Mount Haggin WMA located directly east of the IA. The RA contains a mixture of grasslands along low-lying areas and southern slopes, coniferous forests, and alpine meadows. RA vegetation survey sites (conducted by BRI, Summer, 2000) were located along the Beaver Creek Road, west of the road along Whitepine Creek, and to the southeast of High Rye Guard Station.

2.2 Land Use & Ownership

The IA is managed by Montana Fish, Wildlife and Parks as wildlife habitat.

2.3 Landforms & Soils

The Mount Haggin WMA is located in the Continental Divide Uplands (Ecological Subsection M332Ea) of Southwestern, Montana (Nesser, Ford et al. 1997). Elevation throughout the area of interest ranges from approximately 4,800 to 7,700 feet. Dominant landforms are foothills, mountain slopes, alpine ridges, plateaus, and cirques. These block fault mountains are derived from a variety of igneous, sedimentary, and metasedimentary rocks. A majority of the rock formations observed are of volcanic origin with soils derived from rhyolite and rhyolitic tuffs.

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[1] Planimetric acreage.

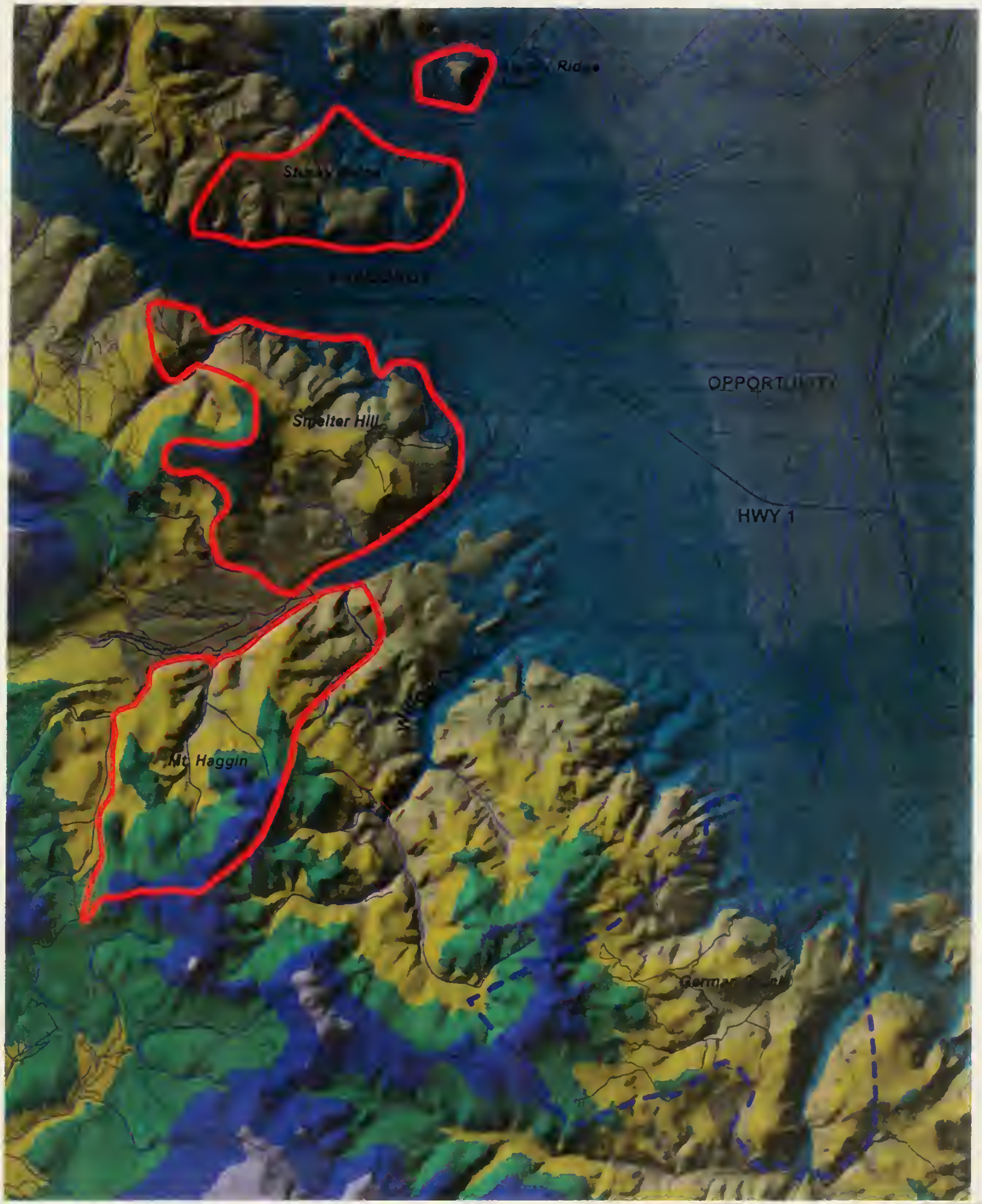


FIGURE 2.1.1

Area of Interest Overview Map

German Gulch Reference Area and Mt. Haggin, Smelter Hill, & Stucky Ridge Injured Area Locations

Bitterroot Restoration
PIONEERING SCIENTIFICALLY BASED ECOLOGICAL RESTORATION

German Gulch Reference Area - BRI 2001
🟥 Injured Area Boundaries
Roads
Streams and Rivers

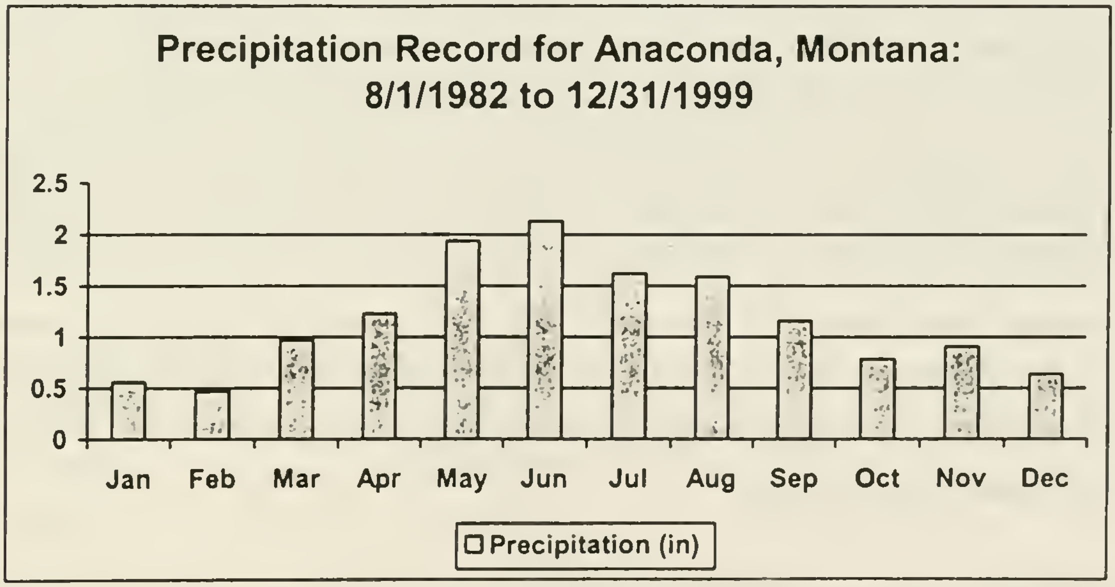
Elevation Model

- 4500' - 5000'
- 5000' - 5500'
- 5500' - 6000'
- 6000' - 6500'
- 6500' - 7000'
- 7000' - 7500'
- > 7500'

2.4 Climate

The Anaconda climate is semi-arid with moderate wind conditions, long cold winters, and cool summers (EPA and MDEQ 1998). Patterns of precipitation and temperature are described based upon the National Climatic Data Center site in Anaconda (elevation 5,511), the closest available climate data. The average annual temperature is 43°F. The warmest month is typically July (79°) and the coldest is January (14.5°) based on a 30-year mean maximum daily temperature. Mean annual precipitation is 14 inches with peak precipitation occurring during May (1.9 inches) and June (2.3 inches). Mean annual snowfall is 63 inches based upon data collected from 1951 through 1974. In general, precipitation will increase with elevation and temperature and evapotranspiration will decrease between the Anaconda weather station and the upper elevations of the IA. Mean temperature follows a similar pattern with large daily fluctuations occurring throughout the day.

Figure 2.4.1. Precipitation record for Anaconda, Montana (WRCC 2001).



2.5 Wildlife

Wildlife resources found within the Anaconda Uplands are those adapted to semi-arid montane conditions and plant communities associated with such areas (Montana 1995). The RA contained abundant sign of elk, moose, and black bear associated with forest and forest openings.

Prominent bird species observed throughout the RA included Clark's nutcracker and red crossbill associated with coniferous tree canopies and mountain bluebird associated with forest edge and open habitats. Typical wildlife associated with these upland habitats include birds of prey, woodpeckers, songbirds, squirrels, porcupine, marten, black bear, moose, elk, deer, invertebrates, amphibians, and reptiles (EPA and MDEQ 1998). Riparian and wetland species found in undisturbed habitats include birds of prey, waterfowl, woodpeckers, songbirds, otter, muskrat, mink, raccoon, beaver, deer, amphibians, reptiles, and invertebrates (EPA and MDEQ 1998). The ROD indicates that federally endangered species such as the peregrine falcon and gray wolf and threatened species such as the bull trout may occur within the ARWWS OU. A complete list of mammals and birds characteristic of the IA prior to injury is located in **Appendix B**.

2.6 Native Plant Communities

Native plant communities of the RA are generally distributed across a moisture gradient. The moisture gradient across the area's complex mountain topography is best defined in terms of elevation, topographic-moisture, and soil characteristics. Elevation is the most widely recognized and consistent zone for classification of montane vegetation (Pfister, Kovalchik et al. 1977; Peet 1988). Zones recognized in order of increasing elevation for southwestern Montana include: 1) limber pine zone; 2) Douglas fir zone; 3) lodgepole pine zone; 4) Englemann spruce zone; and 5) sub-alpine fir zone (Pfister, Kovalchik et al. 1977). Also, fescue grasslands dominated by rough fescue and Idaho fescue are common within lowland and foothill areas (Mueggler and Stewart 1980; EPA and MDEQ 1998). In reality, all zones are not necessarily present within each region, nor do they occur strictly within the bounds of an elevation band. For example, northern aspects and high moisture availability tend to lower the elevation at which a particular zone may occur.

Elevation has a substantial effect on vegetation. As elevation increases, temperature drops, wind speed increases and snow depth and duration may increase which all affect soil moisture level and vegetation potential. In addition, the topographic-moisture gradient, or simply put, slope and landscape position, influences the distribution of vegetation. South-facing and ridge top sites are warmer and drier than north-facing slopes and valley bottoms. Also, upper slopes and ridges shed water to lower slopes and valley bottoms thus providing a net gain in moisture for lower areas. Major soil factors other than metals that influence vegetation are texture and depth, both of which affect water availability. In general, trees dominate thin or rocky soils while grasses and forbs form highly competitive sods on deep, fine-textured soils (Peet 1988). Vegetation is generally layered with a tree overstory, shrub mid-story, and grass-forb understory.

2.7 Injury to Mount Haggin Injured Area

Smelter emissions transported by air as well as by water and as fugitive dust arising from exposed tailings are considered to be the primary sources of hazardous substances delivered to the IA (EPA and MDEQ 1998). These hazardous substances included oxides of arsenic, cadmium, copper, lead and zinc, as well as sulfurous compounds (EPA and MDEQ 1998).

2.7.1 Emissions History

The deposition of hazardous substances on the Anaconda Uplands began in 1884 with the construction and operation of the Upper Works facility in Anaconda (Montana 1995; EPA and MDEQ 1998). This operation initially consisted of 26 reverberatory furnaces with individual stacks processing some 500 tons of ore per day. By 1889, the Upper and Lower Old Works were processing 4,000 tons of ore per day. In 1902, the Anaconda Smelter began operations, tripling production to 12,000 tons of ore per day (Montana 1995). A 1907 study (Montana 1995) measured the following average daily release of hazardous material from the Anaconda Smelter:

➢ Arsenic trioxide	29.7 tons/day
➢ Copper	2.2 tons/day
➢ Lead	2.4 tons/day
➢ Zinc	3.1 tons/day

Between 1911 and 1916, average arsenic discharge from the Anaconda Smelter ranged from 40 to 62 tons per day (Anaconda Smelter Smoke Commission n.d. as cited in (Taskey 1972) while between 1914 and 1918, arsenic emissions were estimated at 75 tons per day (Wells 1920 as cited in (Taskey 1972).

Data from October 1976 showed the following daily emissions of hazardous material from the main chimney at Anaconda Smelter (Montana 1995):

➢ Arsenic	6.1 tons/day
➢ Copper	5.2 tons/day
➢ Lead	1.8 tons/day
➢ Zinc	2.2 tons/day

A variety of smelter emissions continued to impact the Anaconda Uplands until the closure of the Anaconda smelter in 1980 (Montana 1995).

2.7.2 Impacts to the Mount Haggin Injured Area

From the Mill Creek region to the Continental Divide, the IA contains slopes that are barren of vegetation and that show signs of extensive soil loss. In addition, extensive areas in the IA, distinct from historically logged zones, are littered with standing dead and/or fallen dead trees (Montana 1995). As shown in **Table 2.7.2.1**, total metals values in the upper 2 inches of soil in the IA were two to three-fold higher relative to the RA. Soil pH data in RDU #15 as assessed during LRES indicates that a majority of samples are below the action level of 5.5. LRES evaluation of the greater IA is necessary in order to further assess impacts caused by emissions.

Table 2.7.2.1. Total Metals Concentrations in the Mount Haggin Injured Area.

Trace Element	Mount Haggin Injured Area (n = 16) Mean ppm (Standard deviation)		Mount Haggin Control Sites (n = 7) Mean ppm (Standard deviation)	
Arsenic*	295.8	(144.6)	99.4	(27.2)
Cadmium*	7.8	(3.7)	2.6	(1.3)
Copper*	356.4	(155.6)	118.7	(50.0)
Lead*	153.3	(49.6)	56.5	(33.1)
Zinc	215.8	(93.7)	115.8	(28.0)

* Statistically significant difference between elemental concentrations of Injured Area and Controls at alpha ≤ 0.01.

Source: (Montana 1995)

Soils from the Mount Haggin IA have been determined to be phytotoxic in controlled laboratory tests (Montana 1995). Further, trace element loading has directly injured vegetation in the upland areas and drastically altered vegetative communities from their original form. The Terrestrial Injury Report (Montana 1995) concludes:

- *"Throughout the* [area], *a community-level phytotoxic response has occurred. This is characterized by reductions in or complete loss of vegetative cover; decreased cover of native plants and increased cover of invasive weed species; and shifts in plant community types from predominantly forests with open grassland to predominantly sparse grassland or bare ground."*

- *"Vegetation community complexity and habitat availability and suitability (measured as number of habitat layers) were negatively (and statistically significant) correlated with degree of phytotoxicity and concentration of hazardous substances."*

- *"Habitat has been significantly reduced in extent and quality for marten (an indicator species for forest habitat) and elk (an indicator species for forest edge/grassland habitat). The viability of wildlife populations that depend on these habitat types therefore has been reduced in the injured areas."*

- *"As a result of habitat loss and degradation, a large number of wildlife species that depend on this habitat are likely to have been lost from the injured area or have undergone population reductions* **(Table 2.7.2.2)**.*"*

The Terrestrial Injury Report (Montana 1995) further concludes that:

- *"The ability of the injured upland areas to revegetate and provide wildlife habitat is precluded by phytotoxic levels of hazardous substances in soils. Throughout much of the injured upland area, current injuries are likely to persist indefinitely without restoration."*

Table 2.7.2.2. Bird and mammal populations that are likely to have been lost or suffered reduced viability due to removal of tree canopy, bole, shrub midstory, understory, and terrestrial subsurface habitat layers in upland injured areas (Montana 1995).

Reduced Viability	*Species Lost*	
Swainsons thrush	Red-tailed hawk	Red-breasted nuthatch
American robin	Sharp-shinned hawk	House wren
Chipping sparrow	Cooper's hawk	Ruby-crowned kinglet
White-crowned sparrow	Northern goshawk	Mountain bluebird
Dark-eyed junco	Blue grouse	Townsend's solitaire
Black bear	Spruce grouse	Cedar waxwing
Ermine	Northern saw-whet owl	Yellow-rumped warbler
Snowshoe hare	Downy woodpecker	Pine grosbeak
Mountain lion	Hairy woodpecker	Red crossbill
Bobcat	Olive-sided flycatcher	Pine siskin
Elk	Western wood-pewee	Evening grosbeak
	Grey jay	Red squirrel
	Stellar's jay	Porcupine
	Clark's nutcracker	Pine marten
	Mountain chickadee	Lynx

2.8 Previous Revegetation Efforts

Since the early 1960s, sporadic attempts have been made to revegetate impacted areas around Anaconda. Between 1960 and 1967, The Anaconda Company planted more than 60,000 Douglas fir and lodgepole pine on the A Hill above Anaconda, in Sheep Gulch and near Mill Creek (NPI n.d.). Another 16,500 lodgepole pine, ponderosa pine and other trees were planted by The Anaconda Company in Sheep Gulch and on the A and C Hills above Anaconda between 1971 and 1977. While the specific planting sites of these initiatives are unknown, the marginal success of the replanting efforts and continued problems with soil erosion led to additional replanting efforts beginning in 1985 (Andreozzi 1993).

Between 1985 and 1992, crews hired by the Anaconda/Deer Lodge City-County Government planted 191,430 tree seedlings on 549 acres and an additional 51,551 shrubs over 83 acres on the A and C Hills (Andreozzi 1993). In addition, approximately 28,000 trees were planted by local schools and community groups on 31 acres. After 8 years, monitoring showed a 64% survival rate across all species, or approximately 223 surviving seedlings per acre. This work indicates that while revegetation may be challenging on the IA, it is feasible.

The Anaconda Revegetation Treatability Study (ARTS) was conducted between 1992 and 1997 to develop in-situ technologies (MSU-RRU 1997). The ARTS study entailed laboratory and greenhouse evaluation of soil treatments, amendments, and species-specific plant responses. The final phase of the ARTS study provided for the implementation of pilot scale demonstration plots on two upland areas. The Smelter Hill study site (Field Site 9) was treated with applications of lime, fertilizer and manure (organic matter) incorporated at various depths. The site was seeded and planted with live seedlings. The Dragstrip Area (Field Site 13) was treated with organic matter, lime, and deep plowing. The treatments applied to both areas resulted in establishment of acceptable vegetation cover and production, a reduction in surface water runoff volumes along with improvements in runoff water quality, a sharp decrease in offsite transport of COCs, and an increase in precipitation infiltration and a reduction in percolation. Key components of revegetation success were lime addition for pH control, organic matter for soil improvement, fertilization, and species selection based upon metals tolerance.

2.9 Proposed Remedy Actions

ARCO Environmental Remediation, L.L.C. (AERL) has developed preliminary design packages, remedial action work plans and storm water control plans for large-scale reclamation on Stucky Ridge, Stucky Ridge North (aka Lost Creek), and Smelter Hill. (AERL 2002; AERL 2001a,b,c,d,e,f,g,h,i,j) On Mount Haggin the portion of the IA to be treated by remedy is a small percentage of the total area. AERL proposes to address through remedial prescriptions a total of 52 acres out of the total 4,091 acres determined as injured by the State of Montana. The goal of these plans is to achieve remedy as required by the ROD. Key components identified in the AUDB for successful reclamation include pH control, rootzone thickness, organic matter, vegetation selection, and other factors related to soil chemistry and application techniques.

The two basic revegetation remedies to be applied to injured areas as proposed within Preliminary Design Package—Mount Haggin RDU 15 are as follows:

1. Well vegetated (WV) or No Action (NA) Areas—These areas will receive no treatment, other than weed control efforts as necessary.

2. Steep Slope Reclamation (SSR) Areas—These areas consist of slopes steeper than 3:1. Remedial actions will include planting of trees, shrubs and grasses (PTSG) as well as on-slope best management practices (BMP) (i.e.-brush boxes and dozer basins). Tree and shrub plantings will consist of 500 stems per acre including a 25% mortality factor. Four specific techniques have been identified: 1) SSR-1—Hand broadcast seeding in conjunction with planting of trees and shrubs; 2) SSR-2—Hand broadcast seeding in conjunction with trees and shrubs, and implementation of on-slope BMPs that do not require mechanized equipment; 3) SSR-3—Hand broadcast seeding in conjunction with planting of trees and shrubs, and implementation of on-slope BMPs requiring mechanized equipment; and 4) SSR-4—Hand broadcast seeding in conjunction with planting of trees and shrubs, and implementation of on-slope BMPs requiring mechanized equipment and slope regrading/recontouring.

The principal objective of these efforts will be to stabilize contaminated and eroding soils through the establishment of metals tolerant vegetation with minimal diversity (EPA 2001). The anticipated results of this effort are a minimum of 45% vegetation cover and approximately 5 species per 100 m^2. Plant species established will be predominantly trees, early and mid-successional shrubs, drought and metals tolerant grasses, and early successional forbs. Vegetation will harvest infiltrating precipitation, reduce wind and water erosion, reduce COC exposure to wildlife, and be consistent with anticipated future land use. These efforts, however, will not address additional acreage at the IA impacted by smelter emissions.

2.10 Relationship of Proposed Remedy Efforts to Restoration

The AUDB recognizes that "remedy...will only meet the Remedial Action Goals and Objectives as stated in the ROD, thereby falling short of a restored condition (EPA 2001)." BRI recognizes that on the limited acreage addressed, the remedy effort will provide site stability, reduced exposure to wildlife, and sustainable vegetation cover, but also believes that a restored condition will not be met. Also, BRI recognizes that:

- Plant species richness resulting from remedy will be substantially lower than a baseline ecosystem. The vegetation resulting from the work plan focuses primarily on early successional and easily established species and fails to address species that previously dominated the site such as rough fescue.

- Plant species abundance resulting from remedy will be substantially lower than a baseline ecosystem. For example, a planting density of 500 plants per acre will not result in the abundance of wildlife forage or cover found under baseline conditions.

- Plant species structure will not necessarily replicate that previously present under baseline conditions. For example, the proportion of forest to grassland will not necessarily represent baseline conditions.

Secondly, BRI recognizes that further efforts could be initiated which would reduce the time to baseline and improve current conditions on the IA, including the following:

- Restoration enhancement plantings that represent mid- to late-seral stages and increase plant species richness, abundance, and structure can be implemented.

- Soil structure can be modified to create conditions that would support a greater variety of plant species and reduce the time required for plant succession.

- Amendments such as lime can be applied to steep slope treatment areas which would consequently reduce the influence of COC on plant community development.

- The proposed fertilization practices can be modified in order to more effectively build nutrient resources within the soil and to favor native perennial species.

- A majority of the Mount Haggin IA has not been evaluated by LRES and will not receive remedy treatment. These areas contain impacted vegetation and should be evaluated by the LRES methodology to determine areas that require further remedy and restoration work.

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SECTION 3

CHARACTERIZATION OF THE GERMAN GULCH REFERENCE AREA

Section 3: Characterization of the German Gulch Reference Area

3.1 Reference Area Characterization

The German Gulch RA was surveyed to determine the diversity of vegetation habitat types and the distribution of specific plant species that are expected to have been present on the IA prior to historic smelting-related disturbances. The survey was conducted using a reconnaissance method known as "habitat typing." The purpose of habitat typing at German Gulch was to observe habitat types on specific landscape positions in order to provide a habitat suitability model or "template" for restoration prescriptions.

The following procedures were utilized to develop this habitat suitability model:

- The diversity and distribution of habitat types were observed through a field investigation of the German Gulch RA.

- Existing habitat types were described based upon field observations and published reference material.

- A habitat suitability model was developed that describes both the distribution of existing habitat types at German Gulch and predicted (restored) vegetation at the IA.

Specific details of these procedures are further described within this section.

3.2 The Habitat Type Concept

Habitat type classification is a land classification system based upon the potential vegetation of a particular landscape (Pfister, Kovalchik et al. 1977). As a tool, habitat types provide restoration ecologists and planners with the ability to understand site environmental factors that impact plant growth and to choose plant species appropriate for restoration of a site. The integrated nature of environmental variables and habitat types allows for large areas to be effectively described and delineated with respect to their vegetation potential.

Habitat typing is conceptually based upon the theory of succession in ecology (Pfister, Kovalchik et al. 1977; Ricklefs 1979). Succession describes a predictable progression of changes in vegetation within a landscape. Progressive stages are termed "seral" stages with a "climax"[2] or final vegetation type dominating a site at the end of succession. An example of this process would be the progression of a logged forest proceeding through an initial seral stage dominated by annual grasses followed by the encroachment of shrubs. Shrubs would subsequently be replaced by seral tree species adapted to dry open growing conditions followed by succession to a stand of "climax" forest tree species adapted to shade.

A "habitat type" is described as "all land areas potentially capable of producing similar plant communities at climax" (Pfister, Kovalchik et al. 1977). Thus, by observing the vegetation growing within an area, the user is able to identify several environmental factors influencing vegetation on the site and is theoretically able to predict which native plant species will (should) eventually grow on a site. Habitat types are named based upon the dominant overstory and understory plant species that are (or would be) present in the climax plant community. For example, a habitat type dominated by Douglas fir in the overstory and pinegrass in the understory is referred to as a "Douglas fir/ pinegrass habitat type." This naming convention will be adhered to throughout this report.

Pfister notes that habitat types "reflect the most meaningful integration of the environmental factors affecting the plant community." The three most meaningful variables associated with the occurrence of habitat types in mountainous regions are slope, aspect, and elevation (Peet 1988) (Pfister, Kovalchik et al. 1977). Elevation strongly influences moisture availability for plant growth due to cooler temperatures and higher precipitation rates at higher elevations. In addition, slope and aspect influence moisture availability. For example, southern exposures and steep topography are susceptible to drying and drainage while northerly exposures and flat topography limit the amount of evapotranspiration from a site. A fourth factor, soil type, influences moisture retention. Coarse-textured soils, for example, drain readily and are prone to drought conditions whereas fine-textured soils with higher levels of clay and silt retain moisture that is more available for plant use. Habitat types, thus, reflect the integration of these environmental variables.

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[2] The authors recognize "climax" as a dated term, but utilize it to remain consistent with Pfister's terminology. See (Ricklefs 1979) page 733.

Habitat type classification has resulted in the development of field manuals with dichotomous keys used for describing the vegetation potential of a region of land. Habitat typing manuals have been created for and are in use by National Forests in several Western states (Youngblood and Mauk 1985; Hoffman and Alexander 1987; Mueggler 1988). In Montana, three separate classifications have been developed for separate cover types: 1) Forest habitat types have been described by Pfister (Pfister, Kovalchik et al. 1977); 2) Grassland and shrubland habitat types in western Montana have been classified by Mueggler (Mueggler and Stewart 1980); and 3) Riparian habitat types have been classified by Hansen (Hansen, Pfister et al. 1995). The Pfister and Mueggler references were used during our investigation of the RA.

3.3 Methods for Determining Diversity & Distribution of Habitat Types

Sampling Year 2000

Site reconnaissance and habitat typing occurred from May 17-19, 2000 and again on June 15, 2000 in order to assess the diversity and distribution of habitat types within the RA. A total of 73 observations were recorded along seven separate routes (**Figure 3.3.1**). Routes were located within various combinations of elevation and aspect gradients, both site factors understood to dictate the occurrence of habitat types. Routes were predetermined in the office, using the GIS maps to locate sites based upon combinations of the above site factors, with particular attention to sites that would correspond well to the occurrence of those conditions at the IA. Some routes were then adjusted in the field upon observing stand conditions and local topography.

Observations were made as follows: Upon leaving a staging area, the vegetation composition was observed at several elevations, aspects, and landscape features. Observation sites were located by selecting distinctive vegetation stands as elevation, aspect, and landscape features changed along the sampling route. Within a distinct stand of vegetation, species composition was compared to dichotomous keys in either of the two habitat typing manuals previously referenced (Pfister, Kovalchik et al. 1977; Mueggler and Stewart 1980). The identified habitat type was entered onto a field data recorder, as were corrected Global Positioning System (GPS) coordinates of the individual survey location. Also recorded at each location were observations of the slope, aspect, elevation, soil texture (upper 6 inches), rock shape, and rock abundance on the ground surface (**Table 3.3.1**). Surface soil texture was determined by scraping back the overlying organic layer (if any) and utilizing the hand texturing method (Singer, Munns 1991). Soils falling within the sandy, loamy sand, and sandy loam texture classes (< 2 mm size fraction) were termed as "coarse." All other soils were termed as "fine."

Landform was determined based upon the topographic features listed in the Montana Habitat Type Field Form (Pfister, Kovalchik et al. 1977). Features noted were "ridge," "upper slope," "mid slope," "lower slope," "bench or flat," and "stream bottom." Rock shape was determined by observing the angular nature of the rock and percent rock cover was recorded using a modified classification system. Slope and aspect were calculated in the office using a GIS analysis of the digital elevation model data for the sites surveyed.

Table 3.3.1. Field data collection parameters.

Parameter	***Attribute***
GPS Position	Montana State Plane Coordinate
Habitat Type	Refer to Mueggler and Pfister
Soil Texture (< 2 mm size)	Coarse/Fine
Rock Shape on ground surface	Rounded/Angular
Percent Rock Cover on ground surface	0-5%/ 5-35%/ 35-70%/ 70-100%
Landform	Stream bottom/bench or flat/lower slope/ mid-slope/ upper-slope/ ridge

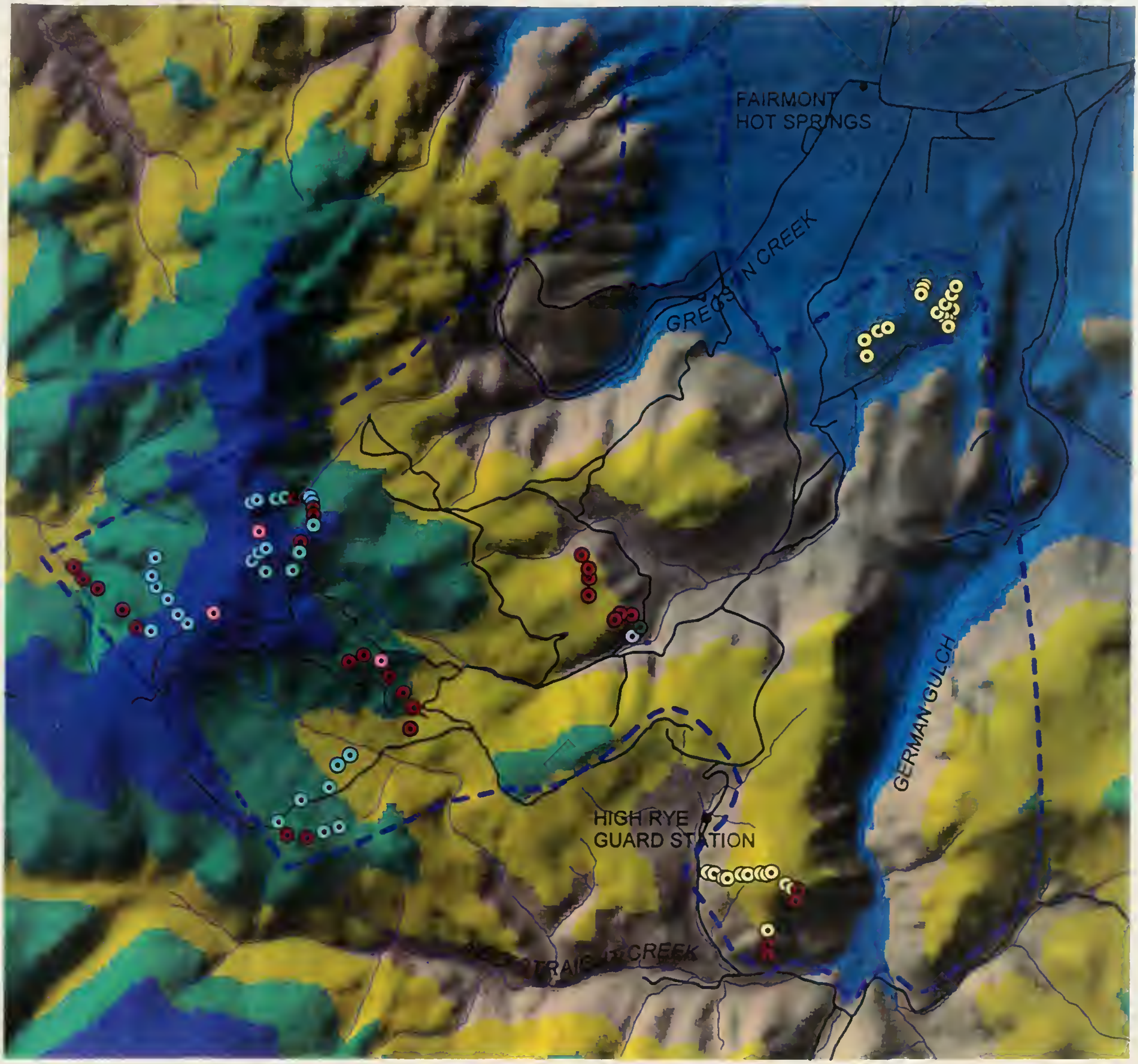


FIGURE 3.3.1

German Gulch Reference Area Survey Locations

Field investigations conducted Summer, 2000 and 2001 by BRI

Bitterroot Restoration

Prior to further analysis, habitat types were aggregated according to their habitat type series (i.e.-- dominant tree species). In this report, these are subsequently referred to as the habitat types for the sake of clarity although they in actuality represent a habitat type "series." Environmental factors evaluated were the separate classes of elevation, aspect, slope, soil texture, percent rock cover, landform and a newly generated factor termed "moisture regime." Moisture regime was created by combining the unique combinations of the elevation and aspect variables. For example, "Moisture regime #1= elevation 5500-6000, north aspect" and "moisture regime #2=elevation 5500-6000, east aspect," etc.

Environmental factors influencing dominant habitat types were evaluated using techniques called Crosstabulation Analysis and Chi-Square Test (Manuganistics 1994). The Crosstabulation Analysis was used to understand patterns of association between measured environmental variables and habitat types. Specifically, the Crosstabulation Analysis created a two-way table that arranged data so that each cell represents a unique combination of the values of the habitat type-environmental variables and the number of observations that fall into each combination of values. A Chi-Square Test was used to test the hypotheses that the observed habitat type and the measured environmental variable were independent. When the Chi-Square Test indicated that variables were related ($p<0.05$), a Mosaic Plot was created to visually represent the environmental breaks that determined the habitat types. These breaks were recorded and incorporated as parameters for spatial analysis modeling.

Sampling 2001

Further sampling was conducted in June 2001 in order to assess low elevation grassland sites. A total of 5 observations were recorded along five separate routes within a low elevation site dominated by grasslands. Routes were located within various combinations of elevation and aspect gradients. Species canopy coverage data was collected utilizing the field forms developed for data collection described in Section 4. Mueggler and Stewart (1980) was used to identify the habitat types which occurred within this area. Their respective aspects and elevations were incorporated into the spatial model.

3.4 Habitat Typing Results

A total of 18 habitat types were observed at German Gulch RA (**Table 3.4.1**). Of the 18 sites, 14 were tree-dominated, 3 were grass-dominated, and 1 was shrub-dominated. Based upon their relative frequency, 9 habitat types accounted for a total of 86% of all observations. These habitat types have been designated as the dominant habitat types of German Gulch. The remaining 9 habitat types account for 14% of the total observations and are designated as minor habitat types.

The Crosstabulation and Chi-Square analysis determined that moisture regime, elevation, aspect, and soil texture were the best predictors of habitat series on German Gulch. Moisture regime, as stated previously, was a combination of the elevation and aspect classes and provided the most useful variable for incorporation into the spatial analysis model. The recognition of moisture as the dominant variable determining habitat types concurs with the current literature for the northern Rocky Mountains (Pfister, Kovalchik et al. 1977; Peet 1988). Soil texture, while significant, provided limited utility in that it only allowed for the differentiation between grassland and forested habitat types.

Table 3.4.1. Habitat types arranged by dominant lifeform in order of decreasing moisture requirement.

Tree-dominated Habitat Types
Subalpine fir/ menziesia
Subalpine fir/ Sitka alder
Subalpine fir/ beargrass
Subalpine fir/ grouse whortleberry
Subalpine fir/ pinegrass
Subalpine fir/ elk sedge
Lodgepole pine/ twinflower
Lodgepole pine/ grouse whortleberry
Lodgepole pine/ pinegrass
Douglas fir/ dwarf huckleberry
Douglas fir/ snowberry
Douglas fir/ pinegrass
Douglas fir/ elk sedge
Douglas fir/ bluebunch wheatgrass
Grass-dominated Habitat Types
rough fescue/ Idaho fescue
Idaho fescue/ bluebunch wheatgrass
rough fescue/ bluebunch wheatgrass
Shrub-dominated Habitat Types
Bitterbrush/ bluebunch wheatgrass

3.5 Description of Habitat Types

The following habitat type descriptions are arranged from highest elevation series (subalpine fir) to lowest elevation series (bitterbrush). Within a series, specific habitat types are arranged in order of highest frequency to lowest frequency. Wildlife use by several dominant species is summarized in **Section 7**.

3.5.1 Subalpine Fir Series

3.5.1.1 Subalpine Fir/ Grouse Whortleberry (*Abies lasiocarpa/ Vaccinium scoparium*) Habitat Type. Subalpine fir/ grouse whortleberry was the dominant habitat type of this series observed at German Gulch, occurring on 11.2 % of the sample sites. This is a common habitat type east of the Continental Divide on broad ridges, gentle slopes, and benches on north and west slopes above 6,500 feet in elevation (Pfister, Kovalchik et al. 1977). Subalpine fir/ pinegrass and Douglas fir/ pinegrass habitat types often occur on adjacent drier sites. This habitat type is considered to be one of the drier habitat types of the subalpine fir series.

Other tree species occurring within this habitat type include lodgepole pine, Engelmann spruce, and Douglas fir. Undergrowth species noted as occurring in this habitat type include grouse whortleberry, pinegrass, elk sedge, woodrush, and *Arnica* species.

3.5.1.2 Subalpine Fir/ Menziesia (*Abies lasiocarpa/ Menziesia ferruginea*) Habitat Type. Subalpine fir/ menziesia occurred only once within sample sites. Pfister notes this habitat type as occurring on moist, highly sheltered slopes at higher elevations. In general, no bare soils or exposed rock occur under this habitat type. This habitat type is commonly associated with non-calcareous soil types.

Other common tree species located within this habitat type are Engelmann spruce, lodgepole pine, and Douglas fir. Shrub diversity on this site was substantially greater than on the drier grouse whortleberry habitat type. Pfister lists the subalpine fir/ menziesia habitat type as containing Sitka alder, globe huckleberry, grouse whortleberry, beargrass, and mountain arnica. Pyrola and round-leaved yellow violet are characteristic herbs.

3.5.1.3 Subalpine Fir/ Sitka Alder (*Abies lasiocarpa/ Alnus sinuata*) Habitat Type. Sitka alder habitat type was noted in scattered stands on isolated benches or where topography allowed for the accumulation of moisture. Pfister describes it as preferring cool and moist upland habitats at elevations between 6,500 and 7,500 feet in elevation. Soils are generally non-calcareous with little or no exposed bare soil and a prominent duff layer.

Other tree species occurring within this habitat type include lodgepole pine, Engelmann spruce, and Douglas fir. Undergrowth species noted as occurring in this habitat type include grouse whortleberry, globe huckleberry, and beargrass with scattered pyrola and mountain arnica.

3.5.1.4 Subalpine Fir/ Beargrass (*Abies lasiocarpa/ Xerophyllum tenax*) Habitat Type. The subalpine fir/ beargrass habitat type occurred only once within the sample sites. Pfister describes this habitat type as common west of the Continental Divide where it is associated with steep dry exposures at elevations between 5,200 and 7,000 feet. Soils are generally non-calcareous with little rock or bare ground exposed and a developed duff layer.

Seral tree species that may occur in this habitat type include lodgepole pine, Engelmann spruce, and Douglas fir. Undergrowth species noted as occurring in this habitat type include grouse whortleberry, globe huckleberry, beargrass, pyrola, and mountain arnica.

3.5.1.5 Subalpine Fir/ Pinegrass (*Abies lasiocarpa/ Calamagrostis rubescens*) Habitat Type. The subalpine fir/ pinegrass habitat type occurred only once within the sample sites. Pfister describes this habitat type as warm dry extreme of the subalpine fir series. As Pfister describes this habitat type as generally occurring on limestone substrates east of the Continental Divide, its presence at German Gulch is anomalous.

Seral tree species that may occur in this habitat type include lodgepole pine, Engelmann spruce, and Douglas fir. Undergrowth species noted as occurring in this habitat type include elk sedge, grouse whortleberry, globe huckleberry, western meadowrue, sweet-cicely, and pyrola.

3.5.1.6 Subalpine Fir/ Elk Sedge (*Abies lasiocarpa/ Carex geyeri*) Habitat Type. The subalpine fir/elk sedge habitat type occurred only once within the sample sites. This habitat type is considered a dry site type of the subalpine fir series. Pfister notes it as a minor habitat type at higher elevations. Soils are both non-calcareous and calcareous with little exposed rock or bare ground and a developed duff layer.

Seral tree species that may occur in this habitat type include lodgepole pine and Douglas fir. Undergrowth species noted as occurring in this habitat type include western meadowrue, sweet-cicely, false Solomon's-seal, and *Arnica* species.

3.5.2 Douglas fir Series

3.5.2.1 Douglas fir/ Pinegrass (*Pseudotsuga menziesii/ Calamagrostis rubescens*) Habitat Type. Douglas fir/ pinegrass was a dominant habitat type at German Gulch and represented 23.6% of the plots sampled. This habitat type occurred on moderately dry mountainsides and upper slopes between 6,000 and 7,000 feet on north and east aspects. Pfister notes this as the highest extension of the Douglas fir series (Pfister, Kovalchik et al. 1977).

The dominant seral tree species observed was lodgepole pine. This habitat type has a diverse shrub understory including spiraea, Oregon grape, common juniper, common snowberry, common chokecherry, and serviceberry. The grass component noted in the habitat type includes pinegrass, elk sedge, bluebunch wheatgrass, Idaho fescue, and rough fescue. Heart-leaved arnica, pussytoes, showy aster, and wild strawberry are the most abundant forbs listed for this habitat type.

3.5.2.2 Douglas fir/ Elk Sedge (*Pseudotsuga menziesii/ Carex geyeri*) Habitat Type. At German Gulch, this habitat type was most commonly observed on moderately steep to very steep slopes at elevations of 6,000 to 7,000 feet. There was a tendency to find this on eastern and southern aspects. The Douglas fir/ elk sedge habitat type occurs on drier sites than the previously discussed Douglas fir/ pinegrass habitat type (Pfister, Kovalchik et al. 1977).

Douglas fir is generally the only tree species found within this habitat type. Common shrub species occurring are common juniper, spirea, common snowberry, serviceberry, ninebark, and Oregon grape. Grass species associated with this habitat type are elk sedge, pinegrass, bluebunch wheatgrass, Idaho fescue, and rough fescue. Dominant forbs are sweet-cicely, western meadowrue, and false Solomon's-seal.

3.5.2.3 Douglas fir/ Bluebunch Wheatgrass (*Pseudotsuga menziesii/ Agropyron spicatum*) Habitat Type. Pfister notes this as the warm-dry extreme of the Douglas fir series occurring at lower elevations with full southern exposure. At German Gulch this habitat type was located between 5,500 and 6,500 feet in elevation on steep southern slopes. This is consistent with Pfister's description.

Other tree species that commonly occur within this habitat type are Rocky Mountain juniper, limber pine, and lodgepole pine. Shrub species common to this habitat type are big sagebrush, russet buffaloberry, bitterbrush, spiraea, Oregon grape, common juniper, common snowberry, common chokecherry, and serviceberry. Vegetation is sparse on this habitat type with bluebunch wheatgrass and arrow-leaved balsamroot occurring as dominant undergrowth species. Idaho fescue can be a common part of this habitat type west of the Continental Divide (Pfister, Kovalchik et al. 1977).

Pfister notes that there is high competition with grasses within this habitat type and that natural regeneration on clearcut sites can take 20-40 years.

3.5.2.4 Douglas fir/ Snowberry (*Pseudotsuga menziesii/ Symphoricarpos albus*) Habitat Type. This habitat type occurred only once within the sample sites. The site was on a lower slope along an eastern aspect between 5,500 and 6,000 feet in elevation. Pfister suggests that this habitat type can occur at much higher elevations although no other stands were located at German Gulch. Pfister notes its common occurrence on warm benches and lower slopes (Pfister, Kovalchik et al. 1977).

This habitat type is similar to the bunchgrass habitat types of this series and reflects a transitional environment between moister habitat types. The shrub and grass components are very similar to that of the Douglas fir/ bluebunch wheatgrass community types. Dominant seral tree species are Rocky Mountain juniper and limber pine. Shrub species occurring are russet buffaloberry, ninebark, spirea, Oregon grape, common snowberry, common chokecherry, and serviceberry. Of interest, bitterbrush is represented in certain phases of this habitat type and may be present at German Gulch. Grass species associated with this habitat type are elk sedge, pinegrass, bluebunch wheatgrass, Idaho fescue, and rough fescue. Dominant forbs are heart-leaved arnica, arrow-leaved balsamroot, and false Solomon's-seal

3.5.2.5 Douglas fir/ Dwarf Huckleberry (*Pseudotsuga menziesii/ Vaccinium caespitosum*) Habitat Type. This habitat type was observed at only one location on an east aspect at 6,500 to 7,000 feet in elevation and is the wettest habitat type of the Douglas fir series observed at German Gulch. In accordance with Pfister, this habitat type occurred on warm, moist well-drained benches and gentle slopes (Pfister, Kovalchik et al. 1977). Typical old growth stands are open and park-like suggesting frequent ground fires (Pfister, Kovalchik et al. 1977). Very little rock or bare soil is exposed on these sites.

Lodgepole pine can be a seral tree species in Douglas fir dominated stands. Undergrowth is dominated by pinegrass, elk sedge, dwarf huckleberry, and bearberry. Common snowberry may also be present.

3.5.3 Lodgepole Pine Series

3.5.3.1 Lodgepole Pine/ Grouse Whortleberry (*Pinus contorta/ Vaccinium scoparium*) Habitat Type. The lodgepole pine/ grouse whortleberry habitat type occurred at 8.1% of the sites sampled. Pfister notes this habitat type as occurring on relatively cold, dry sites on gentle slopes and ridge tops near the Continental Divide (Pfister, Kovalchik et al. 1977). At German Gulch, these communities were located between 7,000 and 7,500 feet in elevation along north and eastern aspects.

As with the previous habitat type, lodgepole pine is the dominant, and generally the only, tree species. Conspicuous understory species found in this habitat type are grouse whortleberry, pinegrass, bearberry, elk sedge, and heart-leaved arnica.

3.5.3.2 Lodgepole Pine/ Twinflower (*Pinus contorta/ Linnaea borealis*) Habitat Type. The lodgepole pine/ twinflower habitat type is restricted to northern and eastern exposures on moderately steep slopes between 6,000 and 7,000 feet in elevation. Pfister lists sites as benchlands and north facing mid-slopes (Pfister, Kovalchik et al. 1977). A well-developed duff layer with little exposed rock and no bare soil characterized the ground layer with soils of non-calcareous origin.

Lodgepole pine is the dominant, and generally the only, tree species found in this habitat type. Undergrowth is dominated by twinflower, globe huckleberry, grouse whortleberry, and pinegrass. Other shrubs of interest are russet buffaloberry, spirea, and common juniper.

3.5.3.3 Lodgepole Pine/ Pinegrass (*Pinus contorta/ Calamagrostis rubescens*) Habitat Type. The lodgepole pine/ pinegrass habitat type was observed at only one location on an east facing mid-slope between 7,000 and 7,500 feet in elevation on a western exposure. A well-developed duff layer with little exposed rock and no bare soil characterized the ground layer with soils of non-calcareous origin.

Lodgepole pine is the dominant and generally the only tree species found in this habitat type. Pfister notes that this is the only tree species that may be successfully replanted in this habitat type (Pfister, Kovalchik et al. 1977). Undergrowth is dominated by pinegrass, elk sedge, spirea, heart-leaved arnica, and bearberry.

3.5.4 Grassland Series

3.5.4.1 Idaho Fescue/ Bluebunch Wheatgrass (*Festuca idahoensis/ Agropyron spicatum*) Habitat Type. Mueggler lists this habitat type as the most frequently encountered mountain grassland habitat type in southwestern Montana (Mueggler and Stewart 1980). In general, it occurred from 6,000 to 7,500 feet in elevation along from rolling terrain to moderately steep mountainsides. This habitat type strongly tended towards the drier south and west aspects.

The dominant forage species within this habitat type are Idaho fescue and bluebunch wheatgrass with prairie junegrass occasionally present. The most abundant forbs generally present are yarrow, Hood's phlox, chickweed, silky lupine, prairiesmoke and rose pussytoes.

3.5.4.2 Rough Fescue/ Idaho Fescue (*Festuca scabrella/ Festuca idahoensis*) Habitat Type. In contrast to the Idaho fescue/ bluebunch wheatgrass habitat type, this habitat type occurs on moister, gentler sloped areas (Mueggler and Stewart 1980). Indeed, sampling data indicate that this habitat type occurred strictly on rolling terrain (slopes<35%) within the 5,500 to 6,000 foot elevation range on west aspects. Meuggler notes that it may be found on any aspect.

Dominant species within these habitat types are western needlegrass, prairiesmoke, northern bedstraw, common harebell, prairie junegrass, silky lupine, wild geranium, and graceful cinquefoil.

3.5.4.3 Rough Fescue/ Bluebunch Wheatgrass (*Festuca scabrella/ Agropyron spicatum*) Habitat Type. This habitat type was found exclusively on western slopes between elevations of 5,500 and 6,500 feet in elevation at German Gulch. Mueggler describes this as a moderately arid habitat type occurring on level topography to steep slopes (Mueggler and Stewart 1980).

This habitat type provides a moderate amount of ground cover consisting mainly of rough fescue, bluebunch wheatgrass, and Idaho fescue. Some common forbs are arrow-leaved balsamroot, Wyoming kitten-tails, indian paintbrush, desert parsley, and silky lupine.

3.5.5 Shrub Series

3.5.5.1 Bitterbrush/ Bluebunch Wheatgrass (*Purshia tridentata/ Agropyron spicatum*) Habitat Type. The bitterbrush/ bluebunch wheatgrass habitat type was observed only once during sampling although variations with a fescue component were observed at various elevations throughout the study area. The site was a dry south-facing slope located at low elevation. Meuggler notes that this habitat type is generally located as small patches in specialized environments (Mueggler and Stewart 1980). Soils for this habitat type are generally described as dry, shallow, and rocky with considerable bare soil and rock exposed at the surface (Mueggler & Stewart 1980).

The shrub community of this habitat type is dominated by open stands of bitterbrush with minor amounts of rubber rabbitbrush and green rabbitbrush. The dominant grass is bluebunch wheatgrass with minor amounts of prairie junegrass, Sandberg bluegrass, and needle-and-thread grass. Common forbs are arrow-leaved balsamroot, golden aster, silky lupine, yellow puccoon, yellow salsify, and yarrow.

3.6 Spatial Analysis of Survey Data and Habitat Modeling

The process previously described for the selection of survey locations, including the survey methods employed at each location, was designed to identify existing habitat types and the site factors that determine their distribution across the landscape at the RA. The process of habitat modeling using GIS software was employed to describe the relationships between site factors and habitat types, and to quantify the occurrence of these same relationships at the IA. The result of this modeling is an understanding of the vegetation communities that would likely have been found at the IA given the absence of historic disturbances, and to describe potential vegetation communities to be restored.

3.6.1 Spatial Analysis Methods

Two habitat models were prepared using ArcView GIS software (ESRI 2000). The first, a "descriptive model" of the occurrence of habitat types at the RA, incorporated observational data collected at each survey location and the site factors (slope, aspect, elevation) characteristic of each location. The product of this descriptive model is a map that displays the assumed distribution of habitat types throughout the RA based upon the observations made at the 73 survey locations. The second, a "predictive model" of the potential habitat types at the IA, is essentially identical to the first model, incorporating the same criteria (site factor combinations and resultant habitat types) to describe the site potential in terms of vegetation. The product of this predictive model is a map that displays the predicted distribution of habitat types throughout the IA based upon the landform characteristics found there and analysis of observations made during the RA surveys.

The basic modeling process utilizes GIS technology (in this case, ArcView 3.2 with the Spatial Analyst 2 extension) to describe the project site using various map layers that represent geographic data (site topography, location of features, etc.) as classified by the user. These map layers can be queried individually or overlaid in combination to provide locational information about features or to create new map layers representing selected attributes or data. For the purposes of this project, map layers were produced representing elevation range, aspect, and percent slope of the entire project area. The analysis of field survey data (described in the **Section 3.3**) provided criteria for the classification of these map layers and the combination of these data to determine the occurrence of habitat types at the RA and, subsequently, the IA.

The habitat typing manuals utilized during the RA field surveys (specifically Pfister, Kovalchik et al. 1977) describe the occurrence of various habitat types within elevation ranges of 500-foot intervals. For this reason, the elevation map created for the model was classified similarly, 6,000'-6,500', 6,500'-7,000', etc. Analysis of the field data also indicated that aspect strongly determined the occurrence of habitat types, so a map layer was created which classified site topography based upon the four cardinal directions (north, south, east, and west) plus flat. Other site factors such as soil type and percent slope were investigated during the analysis of field data but no statistically significant correlations were found which would explain the occurrence of habitat types across the site. Some of this mapped data (such as slope) would enter the spatial analysis later during the prescription phase.

A spatial analysis was performed that incorporated the parameters for habitat type occurrence (as presented in **Table 3.6.1.1** and described in **Section 3.3**) as unique combinations of both elevation and aspect. This process is illustrated by **Figure 3.6.1.1**. The Elevation and Aspect Map layers were combined using a "weighted overlay" process which assigns unique numerical values to each elevation class (ex. 6,000'-6,500' =1, 6,500'-7,000' =2, etc.) and to each aspect class (north =3, south =5, etc.). The map layers are then overlaid and overlapping numeric values are tallied to produce unique values that represent the various combinations of the classes (ex. 6,000'- 6,500'+ North =4, 6,500'- 7,000' + South =7). The map layers resulting from this process each represent the occurrence of a habitat type as a unique combination of those elevation and aspect classes (ex. 6,000'-6,500' + North = 4 =Douglas Fir Habitat) as they occur across the site.

Table 3.6.1.1. Model parameters based upon observed moisture regime of series.

Dominant Series	Elevation Feet	Aspect
Xeric Douglas fir	5000-5500	N
Xeric fescue grassland	5000-5500	S
Xeric fescue grassland	5000-5500	E
Xeric fescue grassland	5000-5500	W
Xeric fescue grassland	5000-5500	Flat
Mesic Douglas fir (no data)	5500-6000	N
Xeric Douglas fir	5500-6000	E
Xeric Fescue Grassland	5500-6000	S
Xeric Fescue Grassland	5500-6000	W
Xeric Fescue Grassland	5500-6000	Flat
Mesic Douglas fir	6000-6500	N
Mesic Douglas fir	6000-6500	E
Xeric Fescue Grassland	6000-6500	S
Xeric Fescue Grassland	6000-6500	W
Xeric Fescue Grassland	6000-6500	Flat
Lodgepole pine & Douglas fir	6500-7000	N
Lodgepole pine & Douglas fir	6500-7000	E
Mesic Fescue Grassland	6500-7000	S
Xeric Douglas fir	6500-7000	W
Xeric Douglas fir	6500-7000	Flat
Subalpine fir	7000-7500	N
Lodgepole pine	7000-7500	E
Mesic Fescue Grassland	7000-7500	S
Subalpine fir	7000-7500	W
Subalpine fir	7000-7500	Flat

The individual Habitat Type maps were then combined to create an overall map of habitats across the site. This combination employs an "arithmetic overlay" process that assigns another unique numeric value to each habitat type. These map layers are then overlaid and the numeric values tallied (in this case, values do not overlap) with the result being a map that displays all of the habitat types on a single map layer. This Habitat Map layer could then be queried to provide information related to the distribution of vegetation types across the site (such as acreage of each habitat type).

3.6.2 Spatial Analysis Results

The results of habitat modeling are map layers portraying the predicted distribution of vegetation communities (series) across the site. Predicted habitat type maps for the German Gulch RA and the IA are presented in **Figure 3.6.2.1** and **Figure 3.6.2.2** respectively. Acreage estimates of predicted vegetation is listed in **Table 3.6.2.1**. This distribution represents the likely occurrence of vegetation communities at the site given the absence of historic disturbances. These results indicate that approximately 25% of the IA would have supported intermountain grassland and shrub communities, with the remaining 75% of the site supporting forest stands, primarily of Douglas fir habitat types. Among these forest community types, mesic Douglas fir forests, which were found to inhabit mid-elevation slopes (5,500'-6,500') on north and east aspects, would have occurred across approximately 40% of the project area. Another 20% of the site would have supported a xeric Douglas fir forest on south aspects at mid-elevations (5,500'-7,000') and west aspects at higher elevations (6,500'-7,000'). Of the various forest communities that constitute the remaining 20% of the site, the subalpine fir community is the most significant, preferring the higher elevations (6,500'-7,500') at west and north aspects.

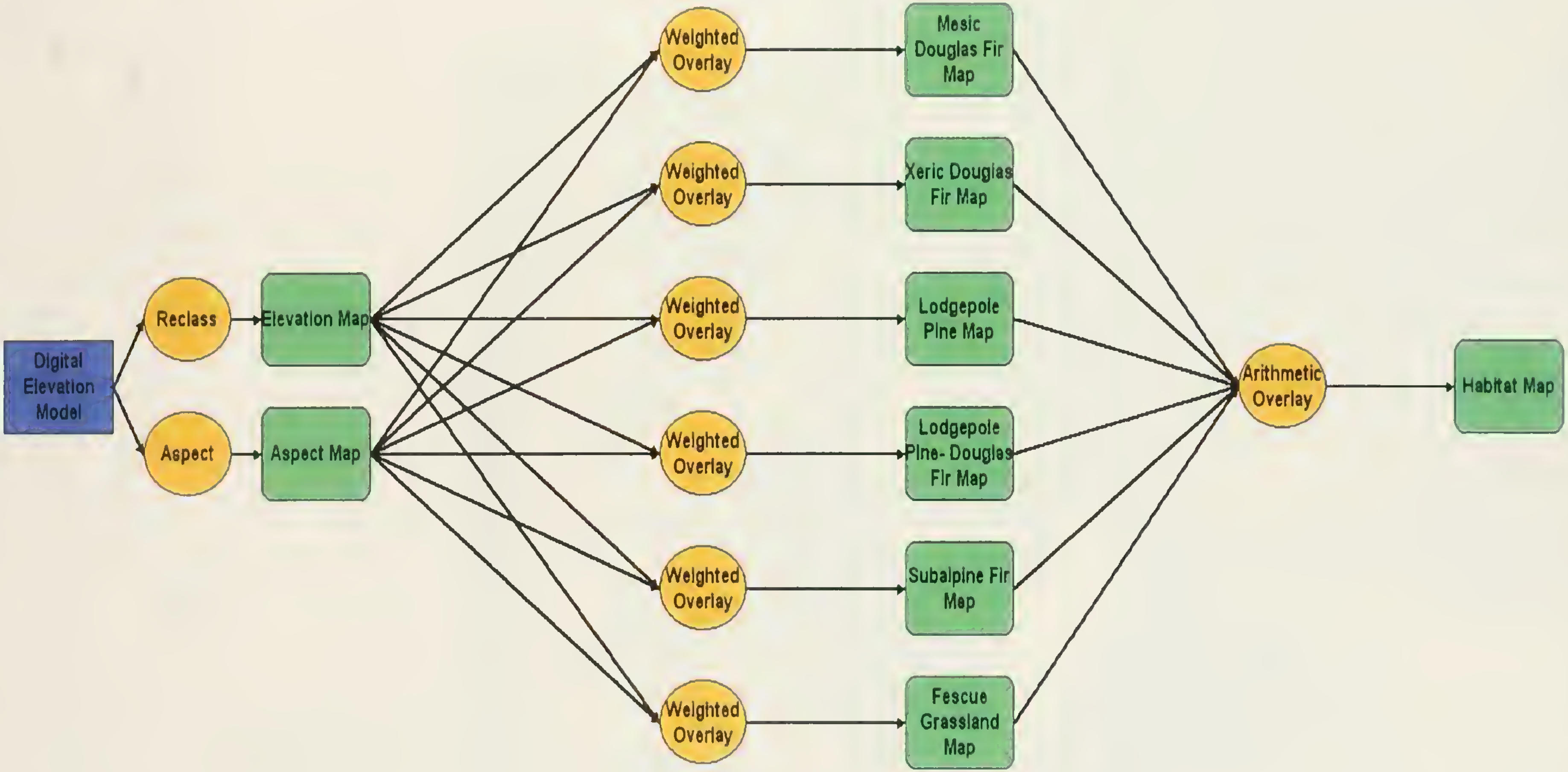
Table 3.6.2.1. Acreage of predicted vegetation series at the Mount Haggin Injured Area.

Series	Predicted Acreage
fescue grassland (xeric)	848.1
fescue grassland (mesic)	187.7
Subalpine fir	348.5
Lodgepole pine/ Douglas fir	678.7
Lodgepole pine	107.5
Douglas fir (xeric)	735.7
Douglas fir (mesic)	1185.2
Total acreage	**4091.4 acres**

Figure 3.6.2.3 compares the existing vegetation on Mount Haggin based on Keammerer's vegetation map of the IA (ARCO 1995) with the overall vegetation communities predicted by BRI's restoration vegetation model. An examination of the existing vegetation map illustrates the paucity of coniferous forest under current conditions. Only 2% of the IA is comprised of coniferous forest, while 67% consists of grassland. BRI's model of predicted restoration

vegetation predicts that 62% of the IA should be coniferous forest, while 22% should be grassland. Aspen and willow stands occupy the remaining 16% of the IA. Aspen and willow stands are not predicted by the vegetation model but are included since they represent areas that will not receive treatment. These stands are generally associated with riparian areas.

Figure 3.6.1.1. Spatial Analysis Model.



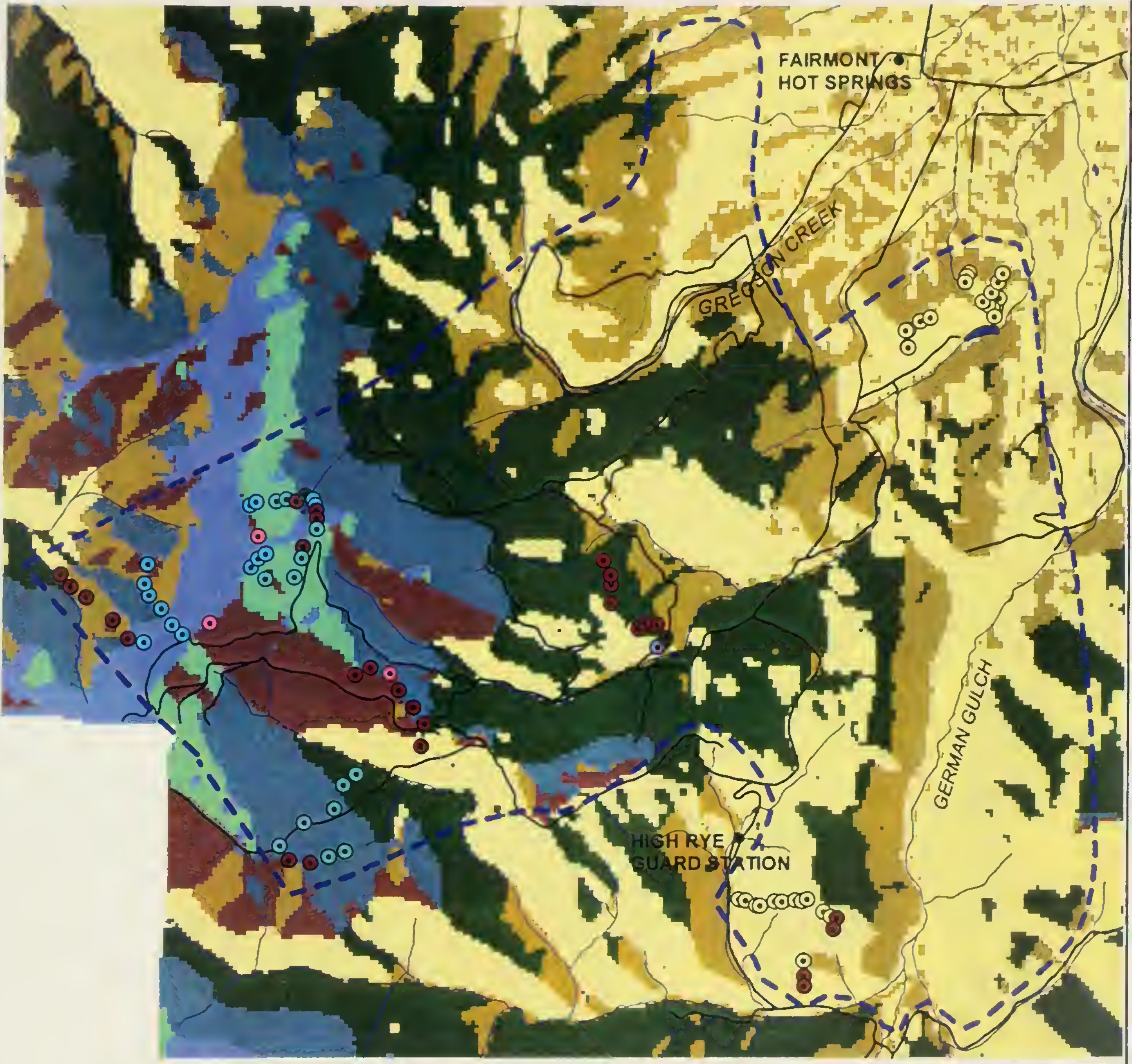

FAIRMONT HOT SPRINGS
GREGSON CREEK
GERMAN GULCH
HIGH RYE GUARD STATION
Predicted Habitat Classes
Douglas Fir (Xeric) Habitat
Douglas Fir (Mesic) Habitat
Subalpine Fir Habitat
Lodgepole Pine Habitat
Lodgepole Pine/Douglas Fir Habitat
Fescue Grassland (Mesic) Habitat
Fescue Grassland (Xeric) Habitat
Streams and Creeks
Roads
Topographic Contours (50 ft.)
Lakes and Reservoirs
German Gulch Reference Area (BRI, 2001)
0 3000 6000 9000 Feet

FIGURE 3.6.2.1

German Gulch Habitat Model

Field investigations conducted Summer, 2000 and 2001 by BRI

Bitterroot Restoration

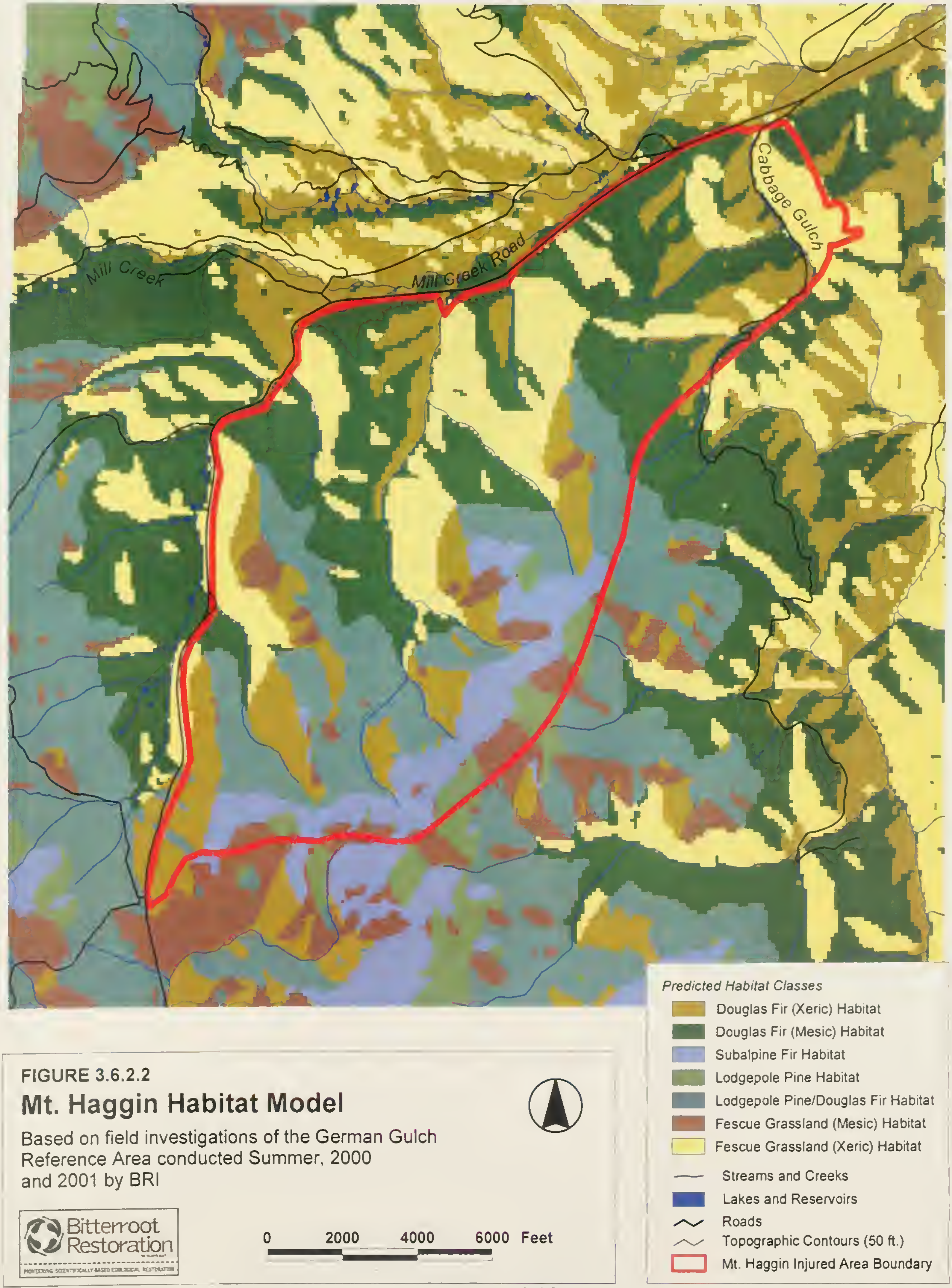
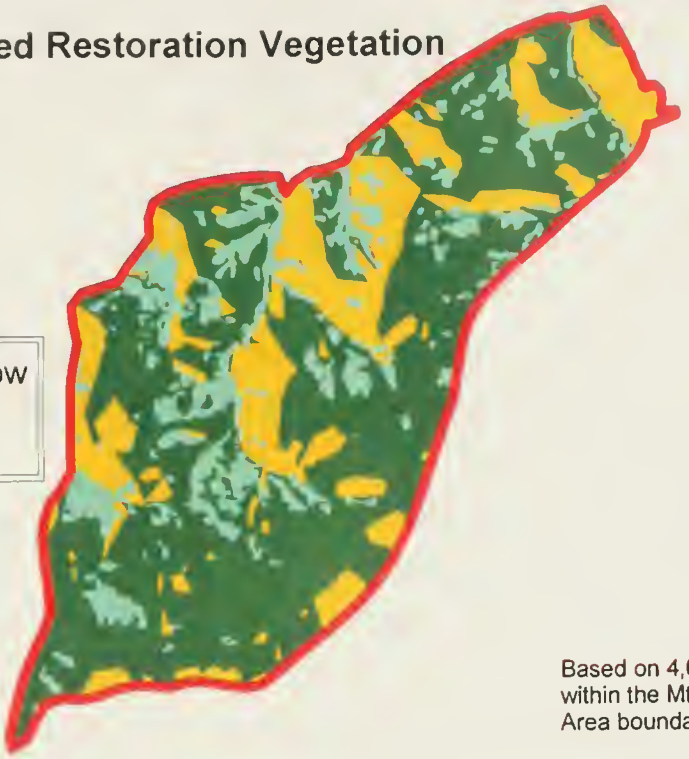

Mill Creek
Mill Creek Road
Cabbage Gulch
Predicted Habitat Classes
Douglas Fir (Xeric) Habitat
Douglas Fir (Mesic) Habitat
Subalpine Fir Habitat
Lodgepole Pine Habitat
Lodgepole Pine/Douglas Fir Habitat
Fescue Grassland (Mesic) Habitat
Fescue Grassland (Xeric) Habitat
Streams and Creeks
Lakes and Reservoirs
Roads
Topographic Contours (50 ft.)
Mt. Haggin Injured Area Boundary
0
2000
4000
6000
Feet
Bitterroot Restoration
PIONEERING SCIENTIFICALLY BASED ECOLOGICAL RESTORATION

FIGURE 3.6.2.2

Mt. Haggin Habitat Model

Based on field investigations of the German Gulch Reference Area conducted Summer, 2000 and 2001 by BRI

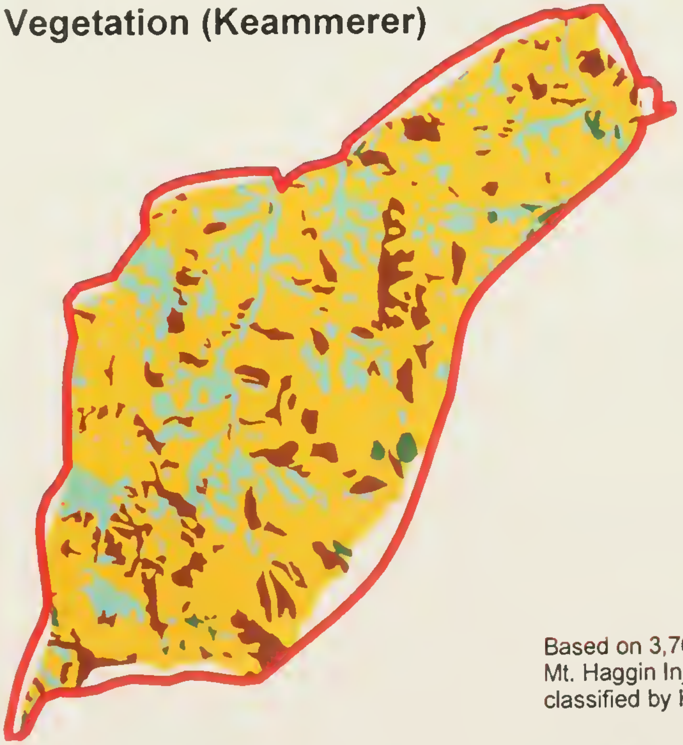
Predicted Restoration Vegetation



16% Existing Aspen/Willow
62% Conifer Forest
22% Grassland

Based on 4,092 acres modeled within the Mt. Haggin Injured Area boundary.

Existing Vegetation (Keammerer)



17% Aspen & Willow
2% Conifer Forest
67% Grassland
14% Bare Areas

Based on 3,768 acres within the Mt. Haggin Injured Area boundary classified by Keammerer.

FIGURE 3.6.2.3

Predicted Restoration Vegetation & Existing Vegetation for Mt. Haggin

Based on spatial modeling conducted by BRI (top map) and a map of existing vegetation developed by Keammerer (ARCO 1995) (bottom map)

Bitterroot Restoration

0 4000 8000 Feet

▭ Mt. Haggin Injured Area Boundary

Vegetation Classes

🟦 Existing Aspen and Willow Stands
🟩 Coniferous Forest
🟨 Grassland
🟥 Bare Areas

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SECTION 4

CHARACTERIZATION OF THE MOUNT HAGGIN INJURED AREA

Section 4: Characterization of the Mount Haggin Injured Area

The IA was investigated in order to assess the extent and character of environmental damage at the site. The purpose of these exercises was to identify and provide supportive evidence for the use of specified site restoration techniques.

4.1 Reconnaissance Field Survey

During the week of June 26-30, 2000 BRI conducted a field investigation to identify and characterize ecological restoration status throughout the IA. Observation categories were selected based on their importance for guiding ecological restoration prescriptions and included:

- Vegetative cover (no cover, low quality grass cover, high quality grass cover, woody plant cover);
- Erosion features (sheet, rill, gully, wind erosion, and mass wasting);
- Browse activity;
- Natural erosion control (rock, woody debris, and litter);
- Soil quality for supporting vegetation (moisture and seedbed).

4.1.1 Sample Selection

Areas to be sampled were selected in the office based upon vegetation cover types identified by Keammerer (ARCO 1995). These vegetation cover types include: barren; grassland; aspen; coniferous; wet meadow; and upland shrub. The field survey was limited to two cover types (barren and grassland) within the IA. Aspen, coniferous, wet meadow, and upland shrub were eliminated from this process due to their perceived recovery.

A total of 40 sites (10 barren plus 30 grass polygons) were sampled (refer to **Figure 4.1.1.1. Mount Haggin Field Survey Locations**). Sampled polygons were chosen in the office by combining:

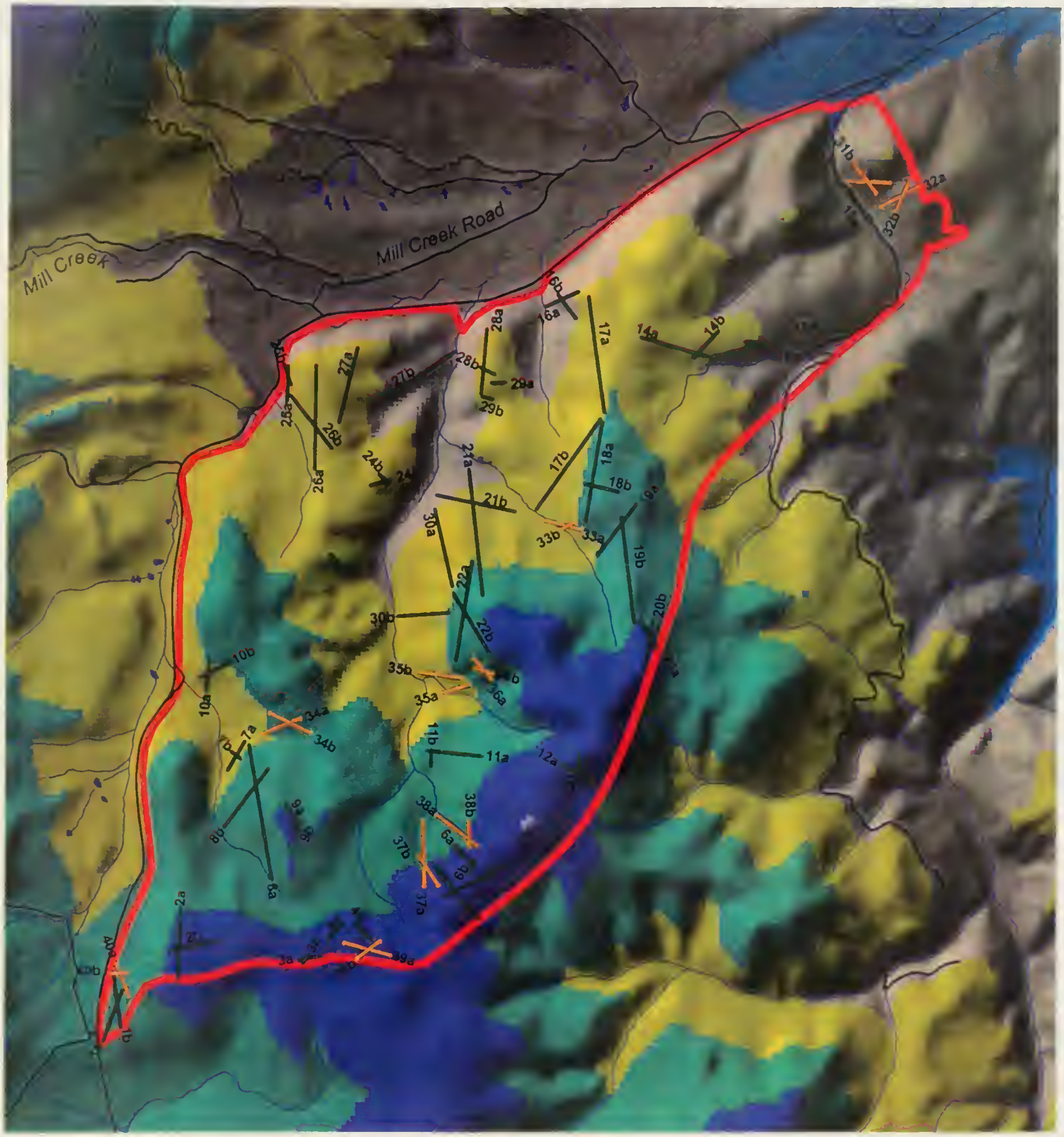
- Barren areas and grassland areas taken from a vegetation map developed by Integrated Geoscience Incorporated (based on updated vegetation type boundaries derived from 1999 satellite imagery);
- A habitat suitability analysis generated from the RA observations relating vegetation to landform position; and
- Random selection.

Areas to be selected were based upon Keammerer's Mount Haggin Existing Vegetation Map (ARCO 1995). Different methods, however, were used to identify sampling sites within the barren and grassland cover types due to their spatial characteristics. For example, barren areas consist predominantly of small (<5.0 acres) discrete polygons while grasslands do not form discrete polygons due to their interconnectedness across the site.

Bare polygons were sorted to identify all polygons greater than 2 acres in size. From this subset of polygons, a random subset of 10 polygons were chosen for sampling.

Grassland polygons were created by overlaying results of a preliminary habitat type suitability model onto the IGI-determined grassland areas. Using GIS maps of the area to be sampled, 5 polygons were randomly selected from within each of 6 vegetation types identified as dominant during the habitat suitability analysis. Each of the resulting 30 grassland polygons was sampled in the field.

In the office, 2 sampling lines were digitized parallel to the major axes of each polygon, depending upon the polygon orientation, and without regard to cardinal directions. Each sampling line began near one edge of the polygon, remained entirely within the polygon



Mount Haggin Injured Area Boundary
Lakes and Reservoirs
Streams and Rivers
Roads
Transects on Bare Ground
Transects on Grasslands

Elevation Model

🟦	4500' - 5000'
🟦	5000' - 5500'
🟨	5500' - 6000'
🟧	6000' - 6500'
🟩	6500' - 7000'
🟦	7000' - 7500'
⬜	>7500'

FIGURE 4.1.1.1

Mt. Haggin Field Survey Locations

Field investigations conducted Summer, 2000 by BRI

Bitterroot Restoration

0 2000 4000 6000 Feet

throughout its length, and ended near the opposite edge of the polygon. Sampling lines were loaded into GPS Data Recorders as ArcView shape (.shp) files.

4.1.2 Field Procedure

Once in the field, the observer used a resource-grade, real-time differentially corrected GPS to navigate to the end point of a sampling line. A resource-grade GPS provides sub-meter accuracy, which will allow anyone with a similar instrument to repeat the observations quite accurately from the same line. In rare cases when the end of a sampling line fell outside of a polygon due to registration errors in the satellite imagery, the observer moved along the line until his location fell within the polygon.

After the observer located a line's end point, he proceeded along the line and observed conditions throughout the polygon. Each sampling line was displayed on the GPS Data Recorder screen so the observer could stay on the line and keep track of his progress along the line. Polygon boundaries also appeared on the screen, along with a scale bar, providing the observer with an accurate indication of the polygon boundary at any location along the line. When walking directly on the sampling line was not possible, for example if the line was on a cliff face, the observer would proceed along a course as close as possible to the sampling line that provided the best possible view of the polygon.

For each polygon, the observer estimated each attribute across the entire polygon based on what was visible from the sampling lines. Data was recorded electronically on the data recorder in data fields that were loaded into the recorder prior to venturing into the field. In addition to the electronically recorded data, the observer recorded general observations in a field notebook. The observer took photographs at each end of each sampling line.

Each polygon contained two sampling lines. In most cases, results from the two sampling lines were different due to the sampling lines' orientation. This occurred because erosion and vegetation patterns are variable within a polygon. For example, a polygon whose boundary includes a ridgeline might be affected by wind erosion at the ridgeline, sheet and rill erosion at the upper slope position, and gully erosion at the lower slope position. A sampling line perpendicular to the contour would intercept all of these conditions, while a sampling line parallel to the contour might only encounter one of the erosion types.

This sampling method was selected in order to capture and understand variation on the landscape. Rapid assessment methods, where an observer records overall conditions within a pre-determined area of land, are useful when developing management plans and site prescriptions. Data collected within small sampling frames, or along discrete transects, become problematic when a manager must expand results to the landscape scale. The sampling line method applied at the IA was designed to:

- Provide a repeatable methodology for integrating variability within sampling polygons in a complex landscape;
- Allow the observer to discern universal patterns that reveal guiding principles and form the basis for a landscape-wide restoration plan.

In order to ensure repeatability, the observers spent the first two days working together. For each polygon, the two observers each followed different sampling lines. Upon completion of their observations, they discussed their findings and decided whether differences in their recorded cover values for attributes within a polygon were due to variability within the polygon or other factors. After two days, the observers were confident that they were using the same criteria when recording observations, and that their work was repeatable and consistent.

Field observers estimated cover using the cover class codes in **Table 4.1.2.1**.

Table 4.1.2.1. Cover Estimation.

Cover Class Code	Percent Cover Range*
"T"	<1%
"P"	1-5%
"1"	5-15%
"2"	15-25%
"3"	25-35%
"4"	35-45%
"5"	45-55%
"6"	55-65%
"7"	65-75%
"8"	75-85%
"9"	85-95%
"F"	>95%

* Cover is defined as the percent of the polygon influenced by the downward projection of the attribute being recorded. For example, if the observer assigns the value "4" to woody vegetation, that means that 35-45% of the polygon is covered by woody vegetation. If the observer assigns the value "4" to wind erosion, that means that 35-45% of the polygon contains evidence of wind erosion (pedestaled plants, wave-like deposition, deposition behind woody debris).

Existing vegetation cover has a strong influence on ecological restoration prescriptions. Field observers recorded cover class codes for the following vegetation cover attributes:

- No cover (bare ground);
- Low quality grass cover (includes *Agrostis* spp, downy brome and Japanese brome, leafy spurge, spotted knapweed, Canada thistle, and other thistles). The grasses are included because of their minimal ability to reduce erosion and their tendency to displace native species;
- High quality grass cover (includes *Stipa* spp., *Poa* spp., basin wildrye, *Juncus* spp., *Carex* spp., and other native grasses and grass-like species.);
- Woody plant cover (includes all shrubs and trees.).

For purposes of developing prescriptions, five major observable erosion categories were identified for the IA. These are sheet, rill, gully, slumping (mass wasting), and wind-driven erosion. Sheet, rill, and gully erosion each are driven by surface water impact and runoff. Rain splash, while not included as a category because of the transient nature of its direct effects, is best evidenced by sheet erosion. In most slope situations, soil loss from rain splash is more significant than soil loss from overland flow (Coppin and Richards 1990). Prescriptions account for the need to reduce raindrop impact on the soil surface on sites where sheet erosion is present. Slumping (mass wasting) is driven by deep soil instability, which can be affected by either soil moisture; lack of deep, binding root mass from woody plants; or orientation of underlying bedrock. Wind erosion occurs on exposed areas where the force exerted by wind exceeds the soil's ability to resist detachment. Field criteria by category included:

- Sheet erosion—uniform soil detachment resulting in a general downslope movement of soil particles. No evidence of rills or gullies. Evidenced by pedestaled plants, other indications of a uniform reduction in soil level.

- Rill Erosion—evidenced by visible channels where water can concentrate. Channels are small enough to remove by normal tilling or grading operations (Gray and Sotir 1996).

- Gully Erosion—Intermittent stream channels too large to repair using normal tilling or grading methods.

- Slumping or Mass Wasting—Evidenced by fracture lines parallel to slope contour, or large soil deposits near base of slope.

- Wind erosion—Evidenced by scour marks on existing woody debris or wave-like soil distribution patterns.

Field observers recorded information about several other attributes while on site. These included:

- Moisture—Polygons are either mesic or xeric. Mesic sites are defined as those sites occurring on north and east aspects and appearing to have adequate moisture to support plant growth. Xeric sites are defined as those sites occurring on south and west aspects and appearing to lack sufficient moisture to support plant growth.

- Litter—Defined as percent of the site covered by dead organic debris smaller than 2 inches in diameter.

- Woody debris—Estimated as the average number of downed logs greater than 2 inches in diameter falling within a 100 square feet (10 feet by 10 feet) space.

- Seedbed—Recorded as either mineral or organic. A mineral seedbed is characterized by a predominance of sand or gravel, often parent material on the soil surface; an organic seedbed is characterized by the presence of fine soil particles (sandy loam or finer texture).

- Rocks—Percent cover of rocks greater than 2 inches in the medial dimension. These rocks can potentially serve as armoring for erosion protection.

- Browsed—Percent of woody plants observed within the polygon that exhibit signs of browse.

4.1.3 Office Procedures

4.1.3.1 Field Data Analysis. The purpose of field data analysis was to identify typical characteristics of the vegetation types sampled. Data was entered into spreadsheets and assessed for errors or anomalies. For example, transect lines that transected scree slopes were identified and removed from the data set prior to analysis. The percent of intercept associated with a certain classification (i.e.—erosion class or vegetation type) was multiplied by the individual line length to create an estimate of the line cover represented by this classification. The total line length for a specific classification was then compared to the total length of all transects combined and a percentage estimate derived for each factor. In addition, data were reordered according to slope breaks and evaluated to determine the influence of slope. Summaries and full data sets are reported in **Section 4.2**.

4.1.3.2 Acreage Estimate. A GIS map was used to the estimate the acreage requiring restoration at the IA. Three map layers were used in the analysis: existing vegetation, a slope map, and predicted habitat types for the IA. The latter two layers form the basis for developing site prescriptions.

Existing grasslands were located using Keammerer's Mount Haggin Existing Vegetation Map (ARCO 1995). This map is not a perfect representation of grasslands within the Mount Haggin IA; however, it is the most accurate vegetation map of the area. The most prominent problem encountered was that the map's boundaries were not coincident with the State of Montana's IA boundary.

The first step in the grassland treatment type analysis involved clipping grassland polygons from Keammerer's vegetation map. Next, a slope map was classified into two categories – slopes less than 35% and slopes greater than 35%. A 35% slope break point was used because restoration strategies differ significantly on gentle and steep slopes. The reclassified slope map was intersected with Keammerer's vegetation map resulting in a layer that divided grasslands into gentle and steeply sloped polygons.

The amount of degraded grasslands was based on fieldwork completed in 2000. The existing vegetation, percent cover, soils, and erosion were compiled on 19 grassland transects. Further analysis indicated that approximately 35% of the transects contained less than 30% cover – the LRES standard for adequate vegetative cover for erosion control. The actual location of degraded grasslands has not been determined. Such a designation would require further field mapping.

The acreage estimates derived from this process are presented in **Table 4.1.3.2**. Also included are acreage estimates provided by AERL (AERL 2002) for proposed remedy work designated as "Steep Slope Reclamation" and "Monitoring-Well Vegetated." Excluded from the treatment acreage estimate are existing forest/shrub vegetation (633 acres), areas less than 5 acres in size (570 acres), and the IA outside of the Keammerer boundary (264 acres).

Table 4.1.3.2. Treatment acreage estimate for Mount Haggin.

Treatment Type	Treatment Acreage[1]	Predicted Forest (ac.)	Predicted Grassland (ac.)
Bare Areas	267	215	52
Impacted Grasslands	1098	883	215
Degraded Grasslands	344	286	58
Steep Degraded Grasslands	246	188	58
Monitoring Well Vegetated[2]	615	428	187
Steep Slope Reclamation[2]	54	6	48
Totals	2624	2006	618

1: Grassland and bare areas from Keammerer map based upon 5-acre minimum polygon size.

2: Remedy acreage provided by AERL (AERL 2001a).

Treatment areas greater than 5 acres are illustrated in **Figure 4.1.3.2.1**. SSR polygons (54 acres) were delineated by AERL (AERL 2001a). All SSR polygons portrayed on the map are targeted for restoration under BRI's SSR treatment. Bare ground, calculated at 267 acres, will be treated under BRI's Bare Area treatment. Steep grasslands were derived by intersecting Keammerer's vegetation map with slopes greater than 35%. Based on fieldwork, approximately 35% (246 acres) of the steep grassland polygons are degraded. These areas will be treated under BRI's Steep Degraded Grasslands Restoration treatment. Similarly, 35% (344 acres) of the non-steep grasslands (slopes less than 35%) are considered degraded, and thus slated for BRI's Degraded Grasslands treatment. The remaining 1,098 acres of non-degraded grasslands will be treated under BRI's Impacted Grassland treatment. The 615 acres of polygons delineated as Monitoring-Well Vegetated by AERL will be included with the Impacted Grassland areas.

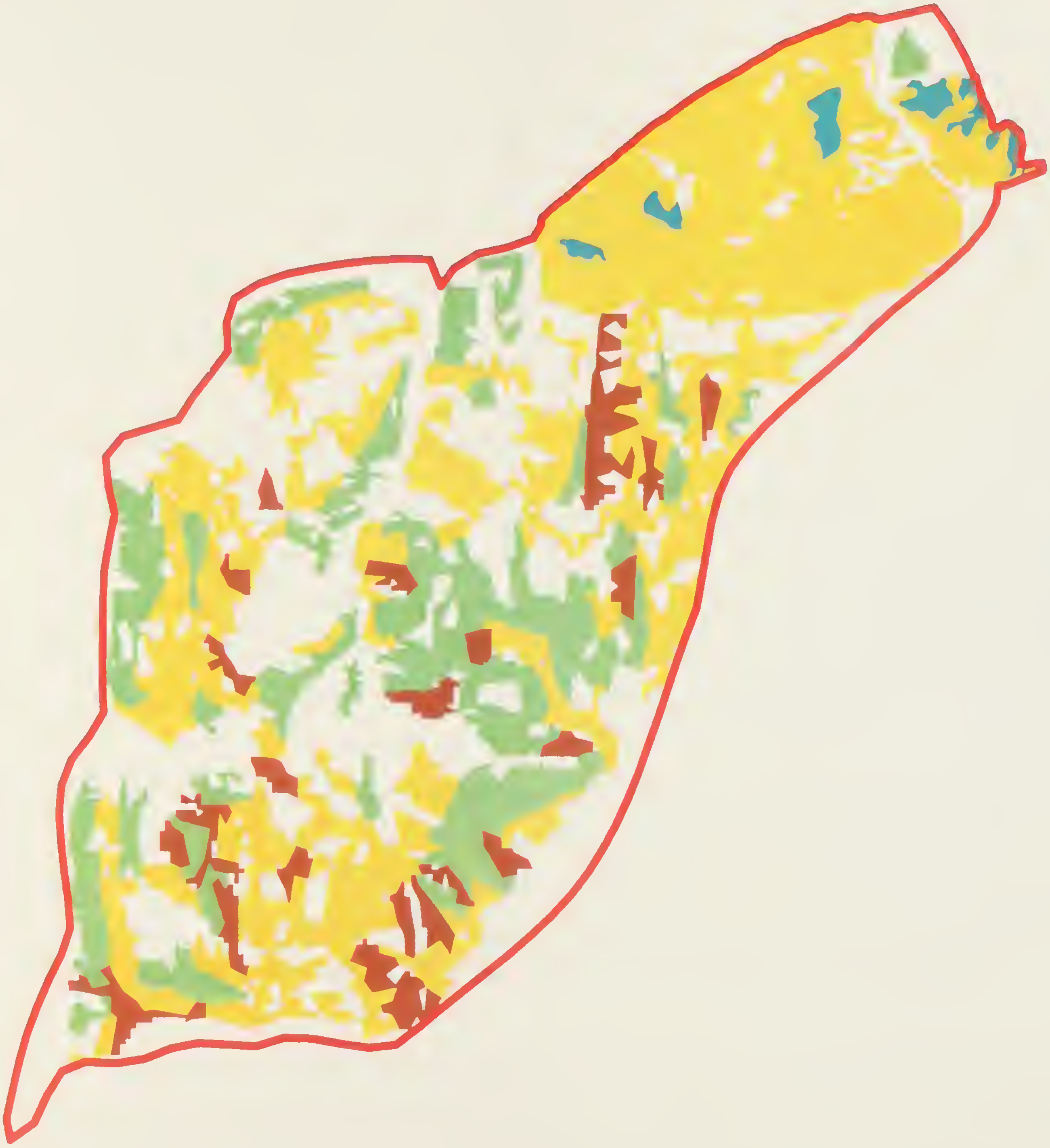


FIGURE 4.1.3.2.1

Treatment Areas Designated for Restoration on Mt. Haggin

Based on spatial modeling conducted by BRI using Keammerer's vegetation map of Mt. Haggin (ARCO 1995).

Bitterroot Restoration

PIONEERING SCIENTIFICALLY BASED ECOLOGICAL RESTORATION

☐ Mt. Haggin Injured Area Boundary

Treatment Areas

🟦 Remedy (SSR)

🟥 Bare Areas

🟩 Steep Grasslands*

🟨 Non-Steep Grasslands**

* Includes 267 acres designated for Steep, Degraded Grassland Treatment & 426 acres designated for Impacted Grasslands Treatment.

**Includes grasslands on slopes < 35% - 344 acres are considered Degraded Grasslands Treatment & 640 acres are Impacted Grasslands Treatment Also included are 615 acres of Remedy (M-WV) Treatment polygons

4.2 Interpretation of Data

During the reconnaissance field survey, 40 polygons were sampled in areas representing the full range of grassland and bare area conditions present on the site. Based on observations, bare and grassland areas were identified as requiring significant restoration actions. Bare and grassland areas are described in separate sections below. The following descriptions apply to general conditions observed in bare and grasslands areas and noted in field books during the reconnaissance field survey.

4.2.1 General Vegetation Composition

Grassland composition in the IA includes species from the following genera: *Agrostis*; *Agropyron*; *Elymus*; *Poa*; and *Stipa*. *Festuca* is conspicuously absent. Several species of *Carex* and *Juncus* occur on the site. A variety of native forbs occur on the site, including species from *Lupinus*, *Aster*, *Epilobium*, and other early successional genera. Invasive weeds occurring on the site include spotted knapweed, leafy spurge, Canada thistle, and other thistles.

Shrubs present in the IA include serviceberry, spirea, chokecherry, Wood's rose, *Ribes* spp., black twinberry, *Symphoricarpos* spp., Rocky Mountain maple, Scouler's willow, Bebb's willow, Canada buffaloberry, bitterbrush, grouse whortleberry, dwarf huckleberry, globe huckleberry, Oregon grape, common juniper, and horizontal juniper. Several shrub species are widely scattered, heavily browsed, and often show signs of stunting or reduced growth.

Tree species present within grassland areas include lodgepole pine, limber pine, Douglas fir, subalpine fir, quaking aspen, and black cottonwood. Lodgepole pine appears to be regenerating along the continental divide at the extreme southern boundary of the IA. Quaking aspen stands are encroaching in several areas that are currently dominated by grasses. Some quaking aspen stands are decadent or dead, particularly at higher elevations.

Many areas that are currently grassland include stumps of conifers that were cut during timber harvesting operations. Stump densities vary from an estimated five per acre to greater than 200 per acre. Higher stump densities occur in the southern and eastern (higher elevation) portions of the IA. Varying densities of downed woody debris occur throughout the IA, indicating that many current grassland areas previously supported conifer forests.

4.2.2 Bare Areas

4.2.2.1 General Characteristics. Bare Areas lack a matrix of established vegetation with substantial bare ground exposed. All Bare Areas are characterized by exposed parent material of volcanic origin. These areas lack soil capable of supporting baseline vegetation communities. Specifically, Bare Areas lack:

- Soil organic matter that provides nutrients (particularly nitrogen);
- Soil organic matter for moisture retention;
- Vegetative material on or above the soil surface to buffer raindrop impacts and limit soil detachment from surface runoff or wind action; and
- Soil organisms, for example mycorrhizal fungi, that assist plants in acquiring nutrients and water.

4.2.2.2 Acreage Estimate. BRI estimates that a total of 267 acres of Bare Area exists as discreet polygons of 5 acres or greater. Of this, 215 acres were previously forested and 52 were previously grassland.

4.2.2.3 Vegetation. Vegetation of Bare Areas is variable, but consistently low in canopy cover. While pockets of native grasses and woody vegetation occur, they typically occur as islands separated by larger areas of unstable soil. Typically, vegetation is lacking (barren ground) within 79.9% of the area examined while stressed and recovering vegetation comprise approximately 9.1% and 11.0% cover respectively. The combined cover of vegetation would not exceed the 30% required by LRES. When subsets of data were examined according to definable slopes, polygons examined on steep and non-steep slopes exhibited similar percentages of area classified as having no vegetation and would require remedy under the LRES cover criteria. Vegetation features observed are summarized in **Table 4.2.2.3.1** and **Table 4.2.2.3.2**.

Table 4.2.2.3.1. Vegetative characteristics of Bare Areas.

	Type of Vegetation		
Site Type	**No Cover—Bare Ground (%)**	**Stressed Vegetation (%)**	**Recovering Vegetation (%)**
All	79.9	9.1	11.0
>35% slope	77.7	13.5	8.9
<35% slope	75.7	10.6	13.7

A. *No Vegetation.* Among 14 sampling lines falling within Bare Area polygons, all 14 had 50% or greater cover of bare ground. Bare ground typically occurred in large patches uninterrupted by vegetation.

B. *High Quality Grass.* Among sampling lines falling within Bare Area polygons, high quality grass represented no more than 3% canopy cover. High quality grass includes *Stipa* spp., *Poa* spp., basin wildrye, *Juncus* spp.; *Carex* spp.; and other native grasses and grass-like species. Within areas delineated as Bare Areas, native grass species only occur as isolated patches in sheltered microsites.

C. *Low Quality Grass.* Low quality grass represented 30% or less canopy cover on Bare Areas. Where it occurred, it typically formed a sparse cover, adding little or no stability to the soil surface. Low quality grass species include *Agrostis* spp, downy brome, Japanese brome, leafy spurge, spotted knapweed, Canada thistle, and other thistles. These species grow on areas that are affected by frequent soil movement. Stems were often buried by surface movement of the soil. While low quality grass species are able to colonize disturbed sites, they do not appear to be increasing soil stability on areas delineated as low quality grasslands.

D. *Woody vegetation.* Woody vegetation occupied 30% or less of areas sampled. Where greater than 10% cover of woody vegetation was observed, it occurred in protected patches, either on a concave landform, or adjacent to sheltered microsites. Due to the patchy nature of their distribution, woody plants offered little or no soil protection.

Typical woody species found on Bare Areas include Oregon grape and serviceberry. Often, these species were buried by the downward movement of soils.

Table 4.2.2.3.2. Vegetation features observed in Bare Areas.

Polygon	Sampling Line	No Vegetation	High Quality Grass	Low Quality Grass	Woody Vegetation
31	31a	70%	0	30%	0.5%
31	31b	60%	3%	3%	0.5%
32	32a	80%	3%	20%	0
32	32b	70%	3%	20%	0
34	34a	60%	0.5%	10%	10%
34	34b	80%	0.5%	0.5%	20%
35	35a	70%	0.5%	0.5%	30%
35	35b	80%	0.5%	10%	10%
36	36a	90%	0	0	10%
37	37a	70%	0.5%	0.5%	10%
37	37b	90%	0	3%	0.5%
38	38a	50%	3%	3%	10%
40	40a	70%	0.5%	3%	30%
40	40b	90%	0	3%	3%

4.2.2.4 Erosion: Water is the most important erosive force in Bare Areas. Water erosion appears to be closely related to slope steepness. In general, 77.3% of the area exhibited erosion with sheet erosion occurring the most frequently among the types of erosion measured. Slopes greater than 35% experienced far greater areas of erosion (97%) than slopes less than 35% (77.3%). Erosion data is reported in **Table 4.2.2.4.1** and **Table 4.2.2.4.2.**

Table 4.2.2.4.1. Erosion characteristics of Bare Areas.

		Frequency of Erosion Type		
Site Type	Area Effected by Erosion (%)	Sheet Erosion (%)	Rill Erosion (%)	Gully Erosion (%)
All	86.0	65.7	12.2	22.1
>35% slope	97.4	76.9	12.3	10.8
<35% slope	77.3	86.5	5.2	8.3

A. *Sheet.* All Bare Areas sampled, with the exception of Polygon 36, which was a talus slope with a greater than 60% slope, experienced sheet erosion. While one of the sampling lines in polygon 40 was recorded as having no sheet erosion, there was significant sheet erosion occurring throughout the polygon between rills and gullies. Sampling line 37a followed a gully down the fall line, so all areas observed from that line were affected entirely by gully erosion. With the exception of these aforementioned sampling lines, observers recorded 50% or greater sheet erosion in all cases. The predominance of sheet erosion will need to be addressed by providing slope breaks with contour wattles and armoring the surface until vegetation can become established.

B. *Rill.* Rill erosion was more common on Bare Areas than on low quality grassland areas. Rill erosion can be addressed using the same structural approach used to address sheet erosion.

C. *Gully.* Gully erosion occurred on 11 out of 14 Bare Areas. Gully erosion can be addressed by installing contour wattles. Observers noted that in areas where natural debris had fallen in a gully, the gully was repairing itself at that point. All gully-forming erosion appears to be occurring at the surface, indicating that a surface treatment should be sufficient to repair gullies.

D. *Slump.* Slumping was not observed in Bare Areas. Most erosion appears to be occurring on the surface.

E. *Wind.* Wind erosion was observed in 7 out of 14 Bare Area sampling lines. Wind erosion can be addressed using surface armoring and contour wattles.

Table 4.2.2.4.2. Erosion features observed in Bare Areas. - -

Polygon	Sampling Line	Sheet	Rill	Gully	Slump	Wind	Slope
31	31a	98%	10%	40%	0	0	35-60
31	31b	98%	70%	30%	0	0	35-60
32	32a	50%	10%	10%	0	0	15-35
32	32b	50%	10%	20%	0	0	15-35
34	34a	60%	0	0.5%	0	10%	15-35
34	34b	80%	0.5%	3%	0	10%	15-35
35	35a	98%	0	0	0	3%	15-35
35	35b	98%	0	0	0	3%	35-60
36	36a	0	0	0	0	0	>60
37	37a	0	0	70%	0	30%	15-60
37	37b	70%	50%	20%	0	30%	15-60
38	38a	80%	10%	3%	0	3%	35-60
40	40a	0%	40%	30%	0	0	15-60
40	40b	80	30%	60%	0	0	15-60

4.2.2.5 Other Surface Features. Other surface features recorded include browse, rocks, litter, moisture, seedbed, and woody debris. These features are summarized in **Table 4.2.2.5.1**.

A. *Browsed*. Percent of shrubs browsed varied widely among sampling lines. This variation was due to accessibility of slopes and species composition. For example, if *Juniperus* spp. comprised a large portion of shrubs observed, this resulted in a lower percent of browsed individuals being recorded due to low palatability of the species. Browse is addressed in prescriptions through the use of tree protectors.

B. *Rocks*. Rocks, while present in large quantities along several sampling lines, are not a strong indicator of the area's inherent erosion resistance. When rocks are associated with a consolidated volcanic parent material, they provide an armoring function. However, when rocks are associated with a degraded tuff parent material, they do not provide significant armoring, as they appear to weather rapidly and be susceptible to water erosion. Soil maps do not provide enough detail to predict parent material across the site in a manner that would inform prescriptions.

C. *Litter*. Litter, when present on the site, is usually associated with inclusions of aspen or high quality grass stands. Litter is not dispersed widely enough, and is not of a sufficient depth to provide significant protection from erosion.

D. *Moisture*. All Bare Area sampling lines occurred in areas having xeric conditions.

E. *Seedbed*. All 14 were recorded as having a mineral seedbed. The predominant absence of organic materials in the soil is a significant constraint to grass and shrub establishment on areas designated as low quality grasslands. Prescriptions must include the addition of organic matter to the site, as well as strategies to encourage natural development of organic soil horizons.

F. *Woody Debris*. Woody debris was variable among sampling lines recorded within Bare Areas. While areas with a density of woody debris greater than one per 100 square feet often exhibited vegetation establishment in the vicinity of the downed logs, the effect was not sufficient to set the site on a trajectory toward recovery. Woody debris will provide high quality microsites during the planting phase of prescriptions.

Table 4.2.2.5.1. Other surface features observed in Bare Areas.

Polygon	Sampling Line	Browsed	Rocks	Litter	Moisture	Seedbed	Woody Debris
31	31a	.5%	3%	0.5%	Xeric	Mineral	0
31	31b	80%	0.5%	0	Xeric	Mineral	0
32	32a	0	0	0.5%	Xeric	Mineral	0
32	32b	0	0	0.5%	Xeric	Mineral	0
34	34a	80%	10%	0	Xeric	Mineral	2
34	34b	90%	20%	0	Xeric	Mineral	2
35	35a	0	0	0.5%	Xeric	Mineral	0
35	35b	0	10%	0.5%	Xeric	Mineral	0
36	36a	0	90%	0	Xeric	Mineral	<1
37	37a	0	20%	0.5%	Xeric	Mineral	1
37	37b	0	0.5%	0	Xeric	Mineral	1
38	38a	50%	30%	0	Mesic	Mineral	3
40	40a	0	3%	0.5%	Xeric	Mineral	<1
40	40b	20%	0.5%	0.5%	Xeric	Mineral	1

4.2.2.6 Proposed Restoration Strategy.

Prescriptions for Bare Areas need to address the following objectives:

- Shorten effective slope lengths on all bare areas, regardless of slope steepness. Where slopes are less than 35%, significant erosion is still occurring, either due to wind erosion or landform position (for example, bare areas on lower slopes may receive significant runoff and soil deposition from upslope areas). Shortening slope lengths will increase surface roughness.
- Reduce the availability of metals;
- Increase soil fertility and organic matter to support a more vigorous vegetation;
- Add an erosion-resistant virgin wood fiber mulch layer to the surface to allow grass to become established on currently unstable soil surfaces;
- Provide favorable microsites for plant growth.
- Establish a more diverse and greater density of native plant cover through active planting efforts;
- Eliminate and control existing noxious weed species.

4.2.3 Grasslands

4.2.3.1 General Characteristics.

Grassland Areas across the IA vary from diverse species associations with adequate erosion control to actively eroding sites dominated by metals tolerant species and noxious weeds. Smelter emissions are assumed to have impacted the entire area. The term "grassland area" therefore describes a highly contrasting vegetative condition with varying potential for the natural recovery of plant materials. For purposes of clarity, grassland areas have been subdivided into three designations: 1) Impacted Grasslands; 2) Degraded Grasslands; and 3) Steep Degraded Grasslands.

Impacted Grasslands are characterized as follows:

- Maintain metals and pH levels that influence but do not control the plant community.
- Reductions in cover and diversity from baseline conditions.
- Maintain noxious weed populations.
- Sufficient vegetative materials are on or above the soil surface to buffer raindrop impacts and limit soil detachment from surface runoff or wind action.

Degraded Grasslands are characterized as follows:

- Slopes < 35%.
- Attain metals levels and low pH that inhibit plant growth and favors metal-tolerant species.
- Maintain noxious weed populations.
- Lack soil organic matter for moisture and nutrient retention.

- Lack vegetative material on or above the soil surface to buffer raindrop impacts and limit soil detachment from surface runoff or wind action.

Steep Degraded Grasslands area characterized as follows:

- Slopes >35%.
- Attain metal levels and low pH that inhibit plant growth and favors metal-tolerant species.
- Lack soil organic matter for moisture and nutrient retention.
- Maintain noxious weed populations.
- Lack vegetative material on or above the soil surface to buffer raindrop impacts and limit soil detachment from surface runoff or wind action.
- Exhibit substantial sheet, rill and gully erosion.

4.2.3.2 Estimated Acreage. Grassland areas exist as a total of 1,688 acres (BRI estimate) as discrete polygons of 5 acres or greater. These areas are divided as follows: 1) Impacted Grasslands = 1,098 acres (65% of total); 2) Degraded Grasslands 344 acres (20% total) and 3) Steep, Degraded grasslands = 246 acres (15% of total).

4.2.3.3 Vegetation. Vegetation of the Grasslands Area overall, is variable, but consistently low in canopy cover. While pockets of native grasses and woody vegetation occur, they typically occur as islands separated by larger areas of unstable soil. Typically, vegetation is lacking within 65.7% of the area examined, while stressed and recovering vegetation comprise approximately 11.9% and 22.4% respectively. The combined cover of vegetation would, however, exceed the 30% required by LRES. When data was examined according to slope, polygons examined on steep slopes exhibited dramatically greater areas classified as having no vegetation and would require remedy under the LRES cover criteria. In contrast, those grass sites on flatter slopes achieved adequate levels of cover. Vegetation features observed along each sampling line are summarized in **Table 4.2.3.3.1** and **Table 4.2.3.3.2**.

Table 4.2.3.3.1. Vegetative characteristics of Grassland Areas.

	Frequency of Vegetation Type		
Site Type	**No Vegetation (%)**	**Stressed (%)**	**Recovering (%)**
All	65.7	11.9	22.4
>35% slope	73.6	3.4	23.1
<35% slope	52.0	21.5	26.6

A. *No Vegetation.* Among 19 sampling lines falling within low quality grassland polygons, 14 had 50% or greater cover of bare ground. Four sampling lines had less than 50% bare ground. Of these, sampling lines 3a and 3b passed through a polygon where wind is the dominant erosive force, exhibiting a scouring effect, thus creating 20-30% bare soil. Sampling line 13b, with 10% bare ground, passes through a grassland dominated by low quality grasses. Sampling lines 16a and 16b pass through a polygon with greater than 50% bare ground in the upslope half of the polygon, which is the portion of the polygon later delineated as low quality grassland.

B. *High Quality Grass.* While high quality grass was present in several polygons, these populations mostly occur on islands of sod that are 1 or 2 inches higher than the surrounding soil. High quality grass includes *Stipa* spp., *Poa* spp., basin wildrye, *Juncus* spp.; *Carex* spp.; and other native grasses and grass-like species. Within areas delineated as low quality grasslands, native grass species do not appear to be increasing.

C. *Low Quality Grass.* Low quality grass did not typically form a sod, nor did it appear to offer protection from water or wind erosion. Low quality grass species include *Agrostis* spp, downy brome, Japanese brome, leafy spurge, spotted knapweed, Canada thistle, and other thistles. These species grow on areas that are affected by frequent soil movement. Stems were often buried by surface movement of the soil. While low quality grass species are able to colonize disturbed sites, they do not appear to be increasing soil stability.

D. *Woody Vegetation.* Woody vegetation represented 20% or less canopy cover on grassland areas. Shrubs observed in low quality grasslands included: serviceberry, spirea, chokecherry, Wood's rose, *Ribes* spp., black twinberry, *Symphoricarpos* spp., Rocky Mountain maple, Scouler's willow, Bebb's willow, russet buffaloberry, bitterbrush, grouse whortleberry, dwarf huckleberry, globe huckleberry, Oregon grape, common juniper, and horizontal juniper. Few tree species were observed in low quality grassland areas. Woody vegetation observed in grasslands, while providing binding root mass near the soil surface, is experiencing soil deposition and suffers from lack of nutrients and dry conditions. For example, sampling lines 16a and 16b passed through an aspen stand that was being buried by the downslope movement of soils.

Table 4.2.3.3.2. Vegetation features observed in Grassland Areas.

Polygon	Sampling Line	No Vegetation	High Quality Grass	Low Quality Grass	Woody Vegetation
2	2a	60%	40%	0%	3%
2	2b	60%	10%	10%	20%
3	3a	30%	40%	20%	3%
3	3b	20%	50%	3%	10%
7	7a	80%	3%	3%	3%
7	7b	90%	0.5%	0.5%	0.5%
8	8a	90%	0.5%	0.5%	0.5%
8	8b	60%	10%	10%	10%
12	12a	60%	10%	3%	10%
12	12b	50%	20%	3%	20%
13	13b	10%	20%	50%	10%
16	16a	40%	0%	0.5%	50%
16	16b	30%	10%	10%	50%
26	26a	50%	20%	20%	10%
27	27a	50%	10%	10%	10%
33	33a	50%	0	30%	10%
33	33b	70%	0	3%	10%
39	39a	70%	0	20%	10%
39	39b	70%	3%	20%	0.5%

4.2.3.4 Erosion. Water is the most important erosive force in grassland areas. The percent of sampling lines affected by water erosion appears to be closely related to slope steepness. In general, 53.7% of the area exhibited erosion with sheet erosion occurring the most frequently among the types of erosion measured. Slopes greater than 35% experienced far greater rates of erosion (64%) than slopes less than 35% (17.9%). Erosion data is reported in **Table 4.2.3.4.1** and **Table 4.2.3.4.2.**

Table 4.2.3.4.1. Erosion characteristics of Grassland Areas.

		Frequency of Erosion Type		
Site Type	**Area Effected by Erosion (%)**	**Sheet Erosion (%)**	**Rill Erosion (%)**	**Gully Erosion (%)**
All	53.7	77.2	17.6	5.3
>35% slope	64.0	87.8	22.1	1.0
<35% slope	17.9	62.6	35.3	2.2

A. *Sheet*. Four of 7 sampling lines with slopes in the 35-60% slope range exhibited 80% or greater cover of sheet erosion. Sampling line 2a, while in the 35-60% slope range, was relatively well armored with hard rock fragments on the surface, providing protection from sheet erosion. Sampling line 8b was similarly armored. Sampling line 16b passed through an aspen stand, which provided some protection from sheet erosion, although most of the stand had been repeatedly buried by loose surface soils. In general, all low quality grassland polygons with slopes greater than 35% should be treated structurally to limit effective slope length and provide a stable rooting medium.

B. *Rill*. Rill erosion was considerably less common on low quality grassland areas than on bare areas. All sampling lines exhibiting rill erosion with 20% cover or greater were near ridge lines. Rill erosion can be addressed using the same structural approach used to address sheet erosion.

C. *Gully*. Gully erosion was relatively insignificant in low quality grassland areas. The majority of sampling lines (13 out of 19) exhibited no gully erosion.

D. *Slump.* Slumping was not observed in low quality grassland areas. Most erosion appears to be occurring on the surface.

E. *Wind.* Wind erosion was significant along sampling lines 3a, 33a, 39a, and 39b. These polygons each occur near ridge lines.

Table 4.2.3.4.2. Erosion features observed in Grassland Areas.

Polygon	Sampling Line	Sheet	Rill	Gully	Slump	Wind	Slope %
2	2a	0%	10%	3%	0	0.5%	35-60
2	2b	20%	30%	10%	0	0	15-60
3	3a	3%	20%	0.5%	0	20%	0-15
3	3b	0	0	10%	0	0	0-15
7	7a	90%	0	0.5%	0	0	35-60
7	7b	98%	0	0	0	0	35-60
8	8a-a	90%	30%	0	0	0	35-60
8	8b	20%	10%	0	0	0	35-60
12	12a	30%	3%	0	0	0.5%	15-60
12	12b	20%	0	0	0	0.5%	15-60
13	13b	0	0	0	0	0	15-35
16	16a	80%	0.5%	0.5%	0	0	35-60
16	16b	40%	0	0	0	0	35-60
26	26a	3%	0.5%	0	0	0	15-35
27	27a	30%	0	0	0	0	15-35
33	33a	80%	0	0	0	10%	15-60
33	33b	90%	3%	0	0	0	15-60
39	39a	20%	20%	0	0	30%	15-35
39	39b	0	20%	0	0	40%	15-35

4.2.3.5 Other Surface Features. Other surface features recorded include browse, rocks, litter, moisture, seedbed, and woody debris. These features are summarized in **Table 4.2.3.5.1**.

A. *Browsed.* Percent of shrubs browsed varied widely among sampling lines. This variation was due to accessibility of slopes and species composition. For example, if *Juniperus* spp. comprised a large portion of shrubs observed, this resulted in a lower percent of browsed individuals being recorded due to low palatability of the species. Browse is addressed in prescriptions through the use of tree protectors.

B. *Rocks*. Rocks, while present in large quantities along several sampling lines, are not a strong indicator of the area's inherent erosion resistance. When rocks are associated with a consolidated volcanic parent material, they provide an armoring function. However, when rocks are associated with a degraded tuff parent material, they do not provide significant armoring, as they appear to weather rapidly and be susceptible to water erosion. Soil maps do not provide enough detail to predict parent material across the site in a manner that would inform prescriptions.

C. *Litter*. Litter, when present on the site, is usually associated with inclusions of aspen or high quality grass stands. Litter is not dispersed widely enough, and is not of a sufficient depth to provide significant protection from erosion.

D. *Moisture*. Because moisture categories (mesic or xeric) were recorded with respect to aspect, they do not provide information suitable for informing prescriptions. Some areas with a potentially mesic microclimate due to their aspect are lacking a soil layer capable of supporting full stands of native vegetation.

E. *Seedbed*. Among 19 sampling lines, 17 were within areas dominated by a mineral seedbed. Sampling lines 13b and 26a, where an organic seedbed was recorded, were at relatively low elevations having greater accumulations of fine soil materials and supporting denser grass communities in areas where vegetation was present. The predominant absence of organic materials in the soil is a significant constraint to grass and shrub establishment on areas delineated as low quality grasslands. Prescriptions must include addition of organic matter to the site, as well as strategies to encourage natural development of organic soil horizons.

F. *Woody Debris*. Woody debris was variable among sampling lines recorded within low quality grassland areas. While areas with a density of woody debris greater than 1 per

100 square feet often exhibited vegetation establishment in the vicinity of the downed logs, the effect was not sufficient to set the site on a trajectory toward recovery. Woody debris will provide high quality microsites during the planting phase of prescriptions.

Table 4.2.3.5.1. Other surface features observed in Grassland Areas

Polygon	Sampling Line	Browsed	Rocks	Litter	Moisture	Seedbed	Woody Debris
2	2a	0	60%	0	Xeric	Mineral	2
2	2b	0	20%	20%	Xeric	Mineral	<1
3	3a	0	60%	0	Mesic	Mineral	0
3	3b	0	20%	40%	Mesic	Mineral	2
7	7a	80%	30%	0	Xeric	Mineral	1
7	7b	90%	30%	0	Xeric	Mineral	1
8	8a-a	90%	30%	0	Xeric	Mineral	2
8	8b	80%	40%	0	Mesic	Mineral	0
12	12a	10%	20%	0.5%	Mesic	Mineral	2
12	12b	20%	30%	0.5%	Mesic	Mineral	3
13	13b	60%	0	30%	Mesic	Organic	<1
16	16a	20%	3%	10%	Xeric	Mineral	1
16	16b	10%	3%	10%	Mesic	Mineral	1
26	26a	50%	3%	0.5%	Mesic	Organic	1
27	27a	80%	0	0	Mesic	Mineral	1
33	33a	40%	3%	0	Mesic	Mineral	1
33	33b	60%	20%	0	Mesic	Mineral	1
39	39a	10%	0.5%	10%	Xeric	Mineral	1
39	39b	0	0.5%	0	Xeric	Mineral	1

4.2.3.6 Restoration Strategies. Grasslands occur in a wide variety of conditions across the Mount Haggin IA. Therefore, separate prescriptions were developed for different grassland designations as follows:

A. *Impacted Vegetation.* Adequate cover exists to control erosion on Impacted Grasslands. The reduction in cover and species richness from baseline conditions, however, has allowed for the invasion of noxious weed species. The prescription for restoring impacted grasslands needs to address the following objectives:

- Monitor vegetation for continued recovery and the status of noxious weed populations.
- Eliminate and control existing noxious weed species.
- Establish a more diverse and greater density of native plant cover;

B. *Degraded Grasslands (slopes less than 35%).* Marginal cover (less than acceptable by LRES standards) is dominated primarily by metals-tolerant species. In addition, these areas have a high potential for erosion. Because these slopes are less steep and have an existing vegetation matrix, in our opinion these slopes are at a lower risk of eroding than steeper slopes once native plant species become established. Prescriptions for Degraded Grasslands address the following objectives:

- Reduce the availability of metals;
- Increase soil fertility and organic matter to support a more vigorous vegetation;
- Provide favorable microsites for plant establishment.
- Establish a more diverse and greater density of native plant cover through active planting efforts;
- Eliminate and control existing noxious weed species.

C. *Steep Degraded Grasslands (slopes greater than 35%).* Because sheet erosion occurs in Degraded Grasslands with an average slope greater than 35%, prescriptions include erosion control measures in addition to revegetation and soil amendment measures. Prescriptions for Steep Degraded Grasslands are aimed at reconstructing the ecosystem, paying special attention to the need for a stable soil surface. While establishing native vegetation on the site is a dominant restoration objective, stabilizing the soil and creating soil conditions that can support native vegetation is a prerequisite to successful restoration. In prescriptions for Steep Degraded Grasslands we address these objectives:

- Shorten effective slope lengths where slopes are greater than 35%;
- Reduce the availability of metals;
- Increase soil fertility and organic matter to support a more vigorous vegetation;
- Provide favorable microsites for plant establishment.
- Establish a more diverse and greater density of native plant cover through active planting efforts;
- Eliminate and control existing noxious weed species.

4.3 Literature Cited

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SECTION 5

COMPARISON OF ALTERNATIVES

Section 5: Comparison of Alternatives

The purpose of this section is to compare proposed alternatives for restoration at the Mount Haggin IA. The three proposed alternatives are 1) No Action Alternative, 2) Stabilization Restoration Alternative, and 3) Active Restoration Alternative. These alternatives vary in their intensity of effort and cost. Initial conditions as determined by the chosen alternative result in different risks, outcomes, and length of time to recovery.

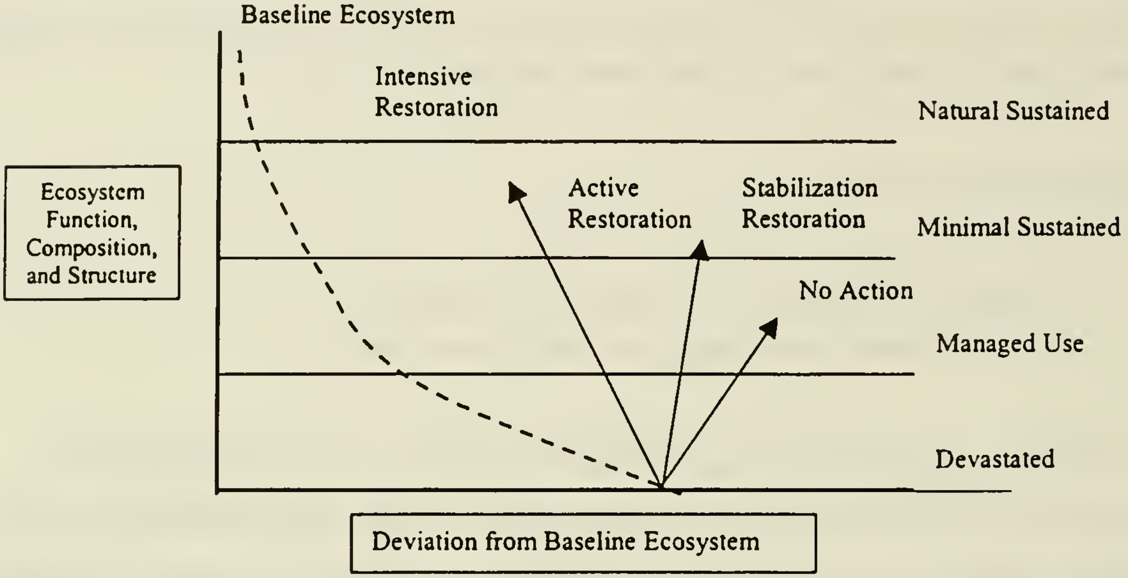
Objectives of this section are:

- To provide a comprehensive comparison of alternatives.
- To present detailed prescriptions and costs for each alternative.

Alternatives were evaluated based upon a modified version of a model developed by the Department of Interior for natural resource damage (DOI 1994). Consideration is given to the primary mechanism for restoration, technical feasibility, coordination with remedy, anticipated ecological response, effectiveness of restoration, time for recovery to baseline, and appropriate area for application, potential for additional injury, potential effects on human health and safety, consistency with relevant federal policy, and compliance with federal law. The final decision for selecting the alternatives will be made by the Trustee of natural resources for the State of Montana.

The alternatives consider three potential outcomes as illustrated in **Figure 5.1**. Degradation of the original ecosystem is described by the descending dashed line and represents the loss of function and structure inherent in the baseline ecosystem. No Action, Stabilization Restoration, and Active Restoration follow separate trajectories that restore portions of the original function or structure. No Action, for example, may follow a trajectory that creates plant communities that are dissimilar to baseline, but nonetheless achieve a minimally sustained or managed use system. In contrast, Stabilization Restoration will focus solely on functional erosion control and a minimally sustained plant community that only partially resembles baseline structure and composition. Amongst these alternatives, the trajectory of Active Restoration efforts bares the closest resemblance to the baseline ecosystem in terms of structure, composition, and function. The result of Active Restoration may be a natural sustained community with durability to naturally occurring events such as drought or weed invasion.

Figure 5.1. Potential trajectories resulting from restoration alternatives as modified from (Traynor and Rieger 1997).



The proposed alternatives rely upon techniques commonly used within the agricultural, forestry, and mine reclamation industries. The tools and products required are commercially available as are companies experienced in the implementation of these techniques. Several opportunities are available to coordinate activities with the limited remedy proposed in the Final Design Report (AERL 2002). A summary of the proposed treatments follows in **Table 5.1.** A summary of the proposed alternatives follows in **Table 5.2.**

Table 5.1. Summary of Treatments.

	Bare Areas		Steep, Degraded Grasslands		Degraded Grasslands		Steep Slope Reclamation (SSR)		Impacted Grasslands[1]	
	site stabilization	active restoration	site stabilization	active restoration	site stabilization	active restoration	site stabilization	active restoration	site stabilization	active restoration
Site Prep./ Amelioration Treatments										
Erosion Control and Sediment Retention Wattle (ESW) Installation (Specification 6.1)	X	X	X	X						
Aerial Application of Agricultural Lime (Specification 6.2)	X	X	X	X	X	X	X	X		
Aerial Application of Fertilizers- Initial Rate (Specification 6.5)	X	X	X	X	X	X		X		
Aerial Application of Compost (Specification 6.6)		X		X		X				
Seeding/ Planting Treatments										
Aerial Seeding (Specification 6.3)	X	X	X	X	X	X				
Aerial Application of Hydromulch (Specification 6.4)	X	X								
Restoration Enhancement Planting (Specification 6.7)		X		X		X		X		X
Install Plant Protectors (Specification 6.8)		X		X		X		X		X
Maintenance										
Aerial Application of Fertilizers- Maintenance Rate- Year 4 (Specification 6.9)	X	X	X	X	X	X				
Maintenance of Erosion Control and Sediment Retention Wattles (Specification 6.10)	X	X	X	X						
Maintenance of Plant Protectors (Specification 6.11)		X		X		X		X		X
Replacement Plant Installation (Specification 6.12)		X		X		X		X		X
Noxious Weed Control (Specification 6.13)	X	X	X	X	X	X	X	X	X	X
Restoration Monitoring (Specification 6.14)	X	X	X	X	X	X	X	X	X	X

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[1] Includes monitoring-well vegetated sites as proposed by ARCO.

Table 5.2. Summary of Alternatives.

	No Action	Stabilization Restoration	Active Restoration
Primary Strategy	Natural recovery	Active erosion control for surface soil stabilization	Active planting efforts with surface soil treatments
Techniques	Remedial action treatments (some areas)	Remedial Action Treatments (some areas) Erosion Control Wattle Installation Fertilizer Application Lime and Seed Application Maintenance Fertilization Noxious Weed Control	Remedial Action Treatments (some areas) Restoration Enhancement Plantings Fertilizer Application Lime and Seed Application on "SSR" Surface Compost Application Noxious Weed Control
Technical Feasibility	Actions are technically feasible	Actions are technically feasible and typical of forestry, mineland reclamation, & contaminated site cleanup/products commercially available	Actions are technically feasible and typical of forestry, mineland reclamation, & contaminated site cleanup/products commercially available
Coordination with Remedy	No coordination required	Possible to coordinate several functions in limited remedy area and reduce costs	Possible to coordinate several functions in limited remedy area and reduce costs
Anticipated Ecological Response	Functional replication	Functional erosion control with minimal compositional /structural replication	Functional and partial compositional/structural replication
Effectiveness & Risks of Strategy	High risk—resulting restoration may not recover to baseline and may further degrade	Moderate risk—erosion control species will establish, but soil factors may inhibit further succession and extend recovery	Moderate risk—mid-successional species will establish, but soil factors may inhibit further succession and extend recovery
Potential of Additional Injury	Potential erosion and noxious weed invasion on slopes	Soil disturbance will possibly result in noxious weed establishment	Soil disturbance will possibly result in noxious weed establishment
Potential Effects on Human Health and Safety	Extended exposure to COCs from eroding slopes	Short-term exposure to implementation crews to COCs.	Short-term exposure to implementation crews to COCs
Appropriate Application Area	"M WV" adjacent to native stands	Highly eroding sites with limited species diversity and soils with chemical and physical deficiencies	Sites with limited species diversity and soils with chemical and physical deficiencies
Time for Recovery to Baseline	>500 years	>250 years	<100 years
Anticipated Costs	$ 0.00	$ 13,479,605	$ 28,139,569

5.1 Restoration Alternatives

5.1.1 No Action Alternative

5.1.1.1 Primary Strategy. The primary strategy for restoration will be no action.

5.1.1.2 Technical Feasibility. The sites will be either accepted in their current state with no assessment for remedy or reclaimed according to remedy treatments proposed within the Preliminary Design Packages without the benefit of further action.

5.1.1.3 Coordination with Remedy. No coordination required on areas where remedy is proposed.

5.1.1.4 Anticipated Ecological Response. The anticipated ecological response for this alternative must consider that remedy is proposed for portions of the IA. The natural recovery alternative could potentially be applied to sites characterized by ARCO and receiving either "Steep Slope Remediation (SSR)" or "Monitoring Well Vegetated (M WV)" remedy treatments. ARCO has determined that a total of 598 acres of the Mount Haggin IA are classified as "Monitoring Well Vegetated" and that 52 acres will receive a PTSG treatment. A majority of the site to which this alternative could potentially be applied has not been mapped or classified for a remedy treatment.

Areas restored via the No Action Alternative will follow a trajectory of continued recovery, a steady state consisting of planted vegetation, or site degradation with no recovery. On those areas of existing native vegetation or exhibiting recovery by native species, continued recovery towards baseline characteristics may be expected. In contrast, actively eroding steep sites in the unclassified area will likely continue to degrade with impacts to downstream surface water quality, off-site transport of COC via wind and water, and no gain in wildlife habitat. On those sites that have been classified by LRES and have received remedy treatments, the planted vegetation can be expected to persist while allowing recovery of native species into the plant community. The plant community arising from these sites will be sustainable but may be minimally similar in terms of baseline species richness and structure for an extended period of time. LRES classified treatments provided with remedy will result in minimal erosion.

Natural recovery within all areas will rely heavily upon the proximity of native stands of vegetation and the ability of individual species to invade established vegetation. Species that successfully colonize will be those transported by wind and adapted to coarse seedbeds and moderate competition. On those areas that do not receive remedy treatments, the vegetation will remain largely influenced by metal levels and erosion potential. Species adapted to frequent burial, highly mineral soils, and elevated COC levels will dominate.

The restoration resulting from the No Action Alternative will be characterized by the following:

1) On remedy sites, soils will be stabilized with no erosion, but remain highly mineral and low in fertility.
2) On unclassified sites, soils will range from highly eroding to well-vegetated.
3) On unclassified sites, off-site transport of COCs via wind and water erosion will continue.
4) On remedy sites, plant species richness will consist of native and non-native reclamation plant species.
5) On unclassified sites, plant richness will vary from fully vegetated native stands to stressed grasslands consisting of metals tolerant species.
6) On both remedy and unclassified sites, plant establishment will occur predominantly adjacent to existing stands of native vegetation.
7) On both remedy and unclassified sites, metals tolerant species will typically be the dominant component of the plant community.
8) Vegetation patterns will not necessarily replicate the natural distribution of native vegetation.

5.1.1.5 Effectiveness and Risk of Strategy. Remedy areas identified as "Monitoring Well Vegetated" will lack the structural and compositional features of the baseline fescue grassland communities. The sites will be dominated by a variety of metals tolerant species, noxious species, and native plant species. Neither the dominant grasses nor forbs will return to grassland sites via natural recovery. Forested sites, however, may recover to a greater extent as witnessed during our field investigation.

Reclaimed steep slope areas will also lack the structural and compositional features of the baseline plant communities. Based upon the preliminary design package for Mount Haggin (AERL 2001a), a variety of native woody species will be planted on steep slopes identified as "SSR-1". The work plan does not differentiate between the baseline condition and the proposed condition, however. For example, slopes that were originally grassland may be planted to woody species. Residual damage or the contaminated soils between the planted woody species will not be limed and remain phytotoxic according to the work plan. BRI assumes that the IA work plan will be developed with similar specifications. Therefore, these areas will be dominated by metals tolerant grasses and weed species indefinitely. Species typical of baseline conditions will not recover naturally on these sites.

Steep slope areas that do not receive remedy treatments will either achieve recovery and be colonized by aspen, conifers, shrub, and metals tolerant grass species or continue to degrade if insufficient material exists on the soil surface to control erosion., The potential for recovery will largely be determined by adjacency to stands of existing vegetation, the presence of stabilizing materials (i.e.—downed trees), and the stability of surface soils. Recovery will vary widely across the site.

Functionally, plant cover resulting from remedy efforts will result in adequate erosion control and provide improved forage for wildlife. On remedy sites, forage will be limited to woody browse on steep slopes and those areas of existing vegetation. For unclassified sites, functionality will be highly variable. Erosion will likely continue to degrade steep bare areas while providing no forage for wildlife. Areas of stressed vegetation will provide minimal erosion control while providing minimal to good forage dependent upon the species present. In contrast, areas of adequate vegetation such as aspen stands and bitterbrush stands will provide functions similar to baseline conditions.

Durability of this restoration will be limited based upon the ability of cover and complexity of vegetation to prevent weed invasion and a potentially limited nutrient pool. SSR sites will remain highly susceptible to weed invasion due to areas of bare ground and residual contamination between planted materials. Unclassified areas will range from well-vegetated areas that demonstrate durability similar to baseline conditions to highly degraded areas and areas of stressed vegetation which demonstrate continuous weed invasion and soil exposure.

5.1.1.6 Potential for Additional Injury. Inadequate plant coverage may result in further erosion on steep slopes and the expansion of noxious weed infestations

5.1.1.7 Potential Effects on Human Health and Safety. Extended time to recovery may result in wind and water erosion on steep slope areas where residual contamination exists. Consequently, humans will be further exposed to elevated levels of COCs.

5.1.1.8 Appropriate Application. This alternative would be appropriately applied on areas adjacent to healthy stands of native vegetation and on soils with physical, chemical, and biological properties similar to baseline conditions. Specifically, this alternative would be appropriately applied on well-vegetated sites adjacent to native vegetation stands.

5.1.1.9 Time for Recovery to Baseline. Recovery to baseline is dependent upon erosion control, noxious weed control, the establishment of a litter layer, reproduction of planted species on the limited areas addressed under remedy, invasion of native species typical of baseline habitat types, and the establishment of a multi-layered canopy. While some natural resources on the Mount Haggin IA will move toward baseline conditions over time, in the absence of substantial restoration efforts, the degree of recovery and total area on which recovery occurs will be contingent upon soil development processes and the ability of individual species characteristic of baseline to migrate and invade successfully, and recovery will be limited due to residual injury on the steep slope areas. Under the No Action Alternative, recovery to conditions somewhat similar to baseline on the Mount Haggin IA will not occur for a time period in excess of 500 years and bare, steep sites will continue to erode to bedrock conditions with no recovery of baseline conditions in the foreseeable future.

5.1.1.10 Anticipated Cost. Total cost for this alternative is $ 0.00.

5.1.2 Stabilization Restoration Alternative.

5.1.2.1 Primary Strategy. The primary strategy for restoration will be active erosion control efforts to provide surface stabilization of soils.

5.1.2.2 Technical Feasibility. The sites will be reclaimed according to the prescriptions summarized in **Table 5-1**. All products are commercially available and techniques are actively used by the agriculture, forestry, mine reclamation, and contaminated site cleanup industries. Stabilization efforts will include:

- Application of contour wattles
- Fertilization
- Lime and seed application
- Maintenance fertilization
- Weed control

5.1.2.3 Coordination with Remedy. On sites receiving remedy treatments (SSR & M WV), liming, weed control, and monitoring activities could be coordinated to reduce overall costs.

5.1.2.4 Anticipated Ecological Response. Areas restored via the Stabilization Restoration Alternative will follow a trajectory of recovery with a primary emphasis on erosion control and heavy reliance upon natural recovery. Stabilization Restoration efforts will focus on integrating physical erosion control measures with erosion control seeding. This alternative will provide for the stabilization of site soils and allow for natural re-establishment to increase species richness and density of vegetation. As well, productivity and nutrient cycling will be encouraged through maintenance fertilization.

The restoration resulting from the Stabilization Restoration Alternative will be characterized by the following:

1) Soils will become stabilized with minimal sheet, rill, or gully erosion.
2) Off-site transport of COCs via wind and water erosion will be reduced or eliminated.
3) Plant species richness will consist of early- to mid- successional species that are primarily wind-pollinated.
4) Plant recovery will occur across the entire site regardless of adjacency to native stands of vegetation.
5) Annual and noxious weed species or metal tolerant species will be a minor component within the plant community.
6) Vegetation patterns will not be similar to the natural distribution of native vegetation.

5.1.2.5 Effectiveness and Risk of Strategy. All areas restored through the Stabilization Restoration Alternative will minimally resemble baseline conditions in terms of structural and compositional features.

The restored areas will contain drought tolerant, rhizomotous and bunchgrass species capable of stabilizing soils. The primary species will be grasses with a minor forb component consisting of legumes and aggressive forb species. Grass and forb species will be native to the Intermountain West but may not be representative of the baseline habitat types. Stabilization of surface soils will allow native vegetation to re-establish over time. In terms of species richness, the Stabilization Restoration Alternative will result in more plant species than the No Action Alternative. It will, however, fall far short of baseline conditions.

Functionally, plant cover resulting from the Stabilization Restoration Alternative will result in adequate erosion control and provide for expanded wildlife forage above the No Action Alternative. Forage within grasslands will be more productive due to fertilization and a greater variety of grass and forb species. Also, organic fertilizer additions and maintenance fertilization will provide for extended release of nutrients throughout the growing season and result in greater utilization and cycling of nutrients. Thus, erosion control will be achieved in a shorter time period than the No Action Alternative.

The Stabilization Restoration Alternative will improve site durability and minimize off-site migration of COC. As a result of increased plant vigor and species richness, the Stabilization Restoration Alternative will result in sites that are less susceptible to invasive weeds and provide a greater measure of resistance to drought and future disturbance over time.

5.1.2.6 Potential for Additional Injury. Activities associated with restoration techniques (deployment of helicopters, foot traffic, and hand planting) will result in soil disturbance and possible noxious weed establishment. Staging areas for disbursement of materials at backcountry sites may result in temporary soil disturbance. The use of helicopters for seeding and hydroseeding will cause temporary disturbance of wildlife residing in intermingled stands of desirable habitat.

5.1.2.7 Potential Effects on Human Health and Safety. Implementation crews will be exposed to COCs on sites during the summer and fall implementation periods.

5.1.2.8 Appropriate Application. This alternative would be appropriately applied on steep slope areas that are actively eroding

5.1.2.9 Time for Recovery to Baseline. Under the site Stabilization Restoration Alternative, recovery of natural resources to baseline conditions will be substantially accelerated compared to the No Action Alternative. Due to the use of basic erosion control measures, and establishment of a limited number of species characteristic of baseline, implementation of this alternative will result in noticeable recovery of natural resources toward baseline conditions in a relatively short period of time following implementation of this alternative, i.e. a number of decades. Full recovery to baseline will be contingent upon soil development processes and the ability of individual species characteristic of baseline to migrate and invade successfully. Full recovery of natural resources will occur in a time period of about 250 years with the exception of soil development, which may take a number of centuries.

5.1.2.10 Anticipated Cost. Total cost for this alternative is $13,479,605. Treatment costs on a per acre basis are as follows: Bare Areas = $ 23,691; Steep Degraded Grassland = $ 14,534; Degraded Grassland = $ 9,112; Steep Slope Reclamation = $ 5,435; and Impacted Grasslands = $ 82.

5.1.3 Active Restoration Alternative

5.1.3.1 Primary Strategy. The primary strategy for restoration will be active planting efforts to increase species richness and surface soil treatments.

5.1.3.2 Technical Feasibility. The sites will be reclaimed according to the prescriptions summarized in **Table 5-1**. All specified products are commercially available and techniques are actively used by the agriculture, forestry, and mine reclamation industries. In addition, Active Restoration efforts will include:

- Wattle installation
- Fertilization
- Compost application in unclassified and SSR areas
- Lime and seed application in unclassified and SSR areas
- Restoration enhancement plantings (addition of 5 species @ 100 stems/acre)
- Maintenance Fertilization
- Weed control

5.1.3.3. Coordination with Remedy. On sites receiving remedy treatments (SSR & M WV), liming, fertilization, planting, weed control, and monitoring activities could be coordinated to reduce overall costs.

5.1.3.4 Anticipated Ecological Response. Areas restored via the Active Restoration Alternative will follow a trajectory of continued recovery. Active Restoration efforts will initiate restoration-planting efforts designed to increase species richness and density of native vegetation as well as minor modifications of the soils chemical and physical characteristics.

The restoration resulting from the Active Restoration Alternative will be characterized by the following:

1) Soils will be capable of supporting disturbance, early, and mid-successional species, and consist primarily of highly mineral, low fertility substrates.
2) Off-site transport of COCs via wind and water erosion will be reduced or eliminated.
3) Plant species richness will consist of mid-successional species that are both wind- and insect-pollinated.
4) Plant recovery will occur across the entire site regardless of adjacency to native stands of vegetation.
5) A greater acreage of contaminated site will be reclaimed and residual contamination reduced.
6) Annual and noxious weed species or metal tolerant species will be a minor component of the plant community.
7) Vegetation patterns will be similar to the natural distribution of native vegetation.

5.1.3.5 Effectiveness and Risk of Strategy. All actively restored,areas will partially resemble baseline conditions in terms of structural and compositional features. Grasslands will contain the dominant grass species typical of baseline (rough fescue and Idaho fescue) as well as numerous forb and native legume species. The addition of surface compost will alter seedbed texture and allow for invasion of additional species adapted to finer textured soils and greater recruitment from seeding efforts. Due to liming and seeding efforts on SSR sites, Active Restoration will extend the structural and compositional components of baseline grasslands to areas not addressed by remedy and in the No Action Alternative. In terms of species richness, however, Active Restoration will fall short of baseline conditions.

Forest restoration efforts will distribute mid-successional tree and shrub species across the extent of the disturbed sites, thus, encouraging more timely canopy coverage on forested sites and a greater potential for invasion of species adapted to shade conditions. Tree and shrub coverage distributed across forested sites will provide browse and hiding cover for wildlife, thus encouraging the transport of bird and animal transported seed. Forest restoration efforts will also fall short of baseline, but will encourage succession and invasion by other native species.

Functionally, plant cover resulting from Active Restoration will result in adequate erosion control and provide for expanded wildlife forage above the No Action Alternative. Forage within grasslands will be more productive due to fertilization and a greater variety of grass and forb species. In addition, insect populations will be encouraged through the planting of insect pollinated species. The Active Restoration Alternative will provide for better retention and cycling of nutrients above the No Action Alternative. Addition of compost will increase nutrient retention in soils allowing for a more efficient use of fertilizer. Also, organic fertilizer additions will provide for extended release of nutrients throughout the growing season and result in greater utilization and cycling of nutrients. Thus, a better structural and compositional replication will be achieved. Fertilization and compost addition will not, however, substantially improve deeper soil structure and moisture retention.

The Active Restoration Alternative will improve site durability and reduce risks above the No Action Alternative. As a result of increased plant vigor and species richness, the site is anticipated to become less susceptible to invasive weeds and to provide a measure of resistance to drought and future disturbance.

5.1.3.6 Potential for Additional Injury. Activities associated with restoration techniques (deployment of helicopters, foot traffic, and hand planting) will result in minor soil disturbance and possible noxious weed establishment. Staging areas for disbursement of materials at backcountry sites may result in temporary soil disturbance. The use of helicopters for seeding and hydroseeding will cause temporary disturbance of wildlife residing in intermingled stands of desirable habitat.

5.1.3.7 Potential Effects on Human Health and Safety. Implementation crews will be exposed to COCs on sites during the summer and fall implementation periods.

5.1.3.8 Appropriate Application. This alternative would be appropriately applied on areas containing limited species richness and soils with physical and chemical deficiencies

5.1.3.9 Time for Recovery to Baseline. Under the Active Restoration Alternative, recovery time to baseline will be shorter than under the Site Stabilization Restoration Alternative due to the extension of plantings across the entire area of disturbance and to the appropriate distribution of grassland and woody species across the site. Recovery will be judged as the successful control of erosion, control of noxious weeds, establishment of a litter layer, reproduction of planted species and invasion of native species typical of habitat types, and the establishment of a multi-layered canopy. Not considered is the development of soils, which may take centuries to accomplish. Anticipated time to full recovery is between 50 and 100 years.

5.1.3.10 Anticipated Cost. Total cost for this alternative is $ 28,139,569. Treatment costs on a per acre basis are as follows: Bare Areas = $33,542; Steep Degraded Grassland = $24,385; Degraded Grassland = $ 18,964; Steep Slope Reclamation = $ 8,970; and Impacted Grasslands = $ 3,596.

5.2 Literature Cited

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SECTION 6

RESTORATION TREATMENTS AND SPECIFICATIONS

Section 6: Restoration Treatments and Specifications

6.1 Erosion Control and Sediment Retention Wattle (ESW) Installation- (Bare Areas and Steep Degraded Grasslands)

6.1.1 Scope of Work

6.1.1.1 Definition. Erosion Control and Sediment Retention Wattles (ESW) are machine-produced tubes of compacted rice straw encased in flexible netting. Two standard sizes are available: either 9" diameter x 25' length, or 12" diameter x 10' length. ESW's are placed and staked along the contour of newly constructed or disturbed slopes.

6.1.1.2 Technical Feasibility.

A. The installation of Erosion Control and Sediment Retention Wattles is specified to address the need to stabilize steep, eroding slopes prior to the implementation of soil amendment and revegetation treatments. ESW's are installed across slopes to help reduce soil erosion and retain sediment. They function by shortening the effective slope length, reducing runoff water velocity, trapping dislodged soil particles, and ameliorating the effects of slope steepness. ESW's are highly effective when they are used in combination with other surface soil erosion/ revegetation practices such as seeding, hydromulching, and planting.

B. Observations and field data collected on the Mount Haggin IA indicate that surficial erosion features (rills, gullies, sheet erosion) were observed on 86% of the Bare polygons sampled and 64% of the "Grassland, Slope >35%" polygons sampled. This occurrence is contrasted with observations made on "Grassland, Slope <35%" polygons, where approximately 18% of survey sites exhibited these features. The agents that cause such erosion features are wind, water, and ice acting upon unprotected (bare) soils (Gray and Sotir 1996). ESW's are utilized to both directly and indirectly address the causes of such erosion types by preventing the formation of rills and gullies and ceasing the continued detachment and downhill movement of soil particles. Once soils are thus stabilized, the establishment of a dense, healthy cover of herbaceous vegetation will provide long-term protection against further wind and water erosion. Refer to **Section 4** for a full discussion of these field observations and collected data.

C. The installation of ESW as an erosion control treatment prior to seeding and planting treatments is specified for all treatment areas within the IA with a slope greater than 35% (Bare Areas (BA) and Steep Degraded Grasslands (SDG)). For BA, 12 inch diameter ESW's shall be installed at 30 foot vertical spacing (measured in the direction of slope). For SDG, 9" diameter ESW's shall be installed as necessary within rill and gully features. An approximate spacing of 60 feet vertical spacing on these sites is used for materials and budget calculations. The larger diameter ESW is specified for BA as it is anticipated that the potential for sediment delivery will be greater in the interim between ESW installation and establishment of permanent vegetative cover.

6.1.1.3 Coordination With Remedy.

A. The installation of ESW is specified for BA and SDG sites, for which there is currently no proposed remedial action. For remedy sites designated as SSR and M WV, erosion control and sediment retention is assumed to be addressed by the proposed remedial action, specifically "engineering controls" installed on slope or at the base of slopes.

B. The installation of Erosion Control and Sediment Retention Wattles is specified to occur during the Summer of Year One.

6.1.2 Products and Materials

6.1.2.1 Erosion Control and Sediment Retention Wattle- 9" diameter.

A. It shall be a machine-produced tube of compacted rice straw and netting. The netting shall consist of seamless, photodegradable, high-density polyethylene and ethyl vinyl acetate and contain ultra-violet inhibitors. The netting shall be filled with compacted rice straw that is Certified Weed Free Forage under California Food and Agriculture Code Section 5101 and 5205. A certificate of weed free status shall be available from the manufacturer. The dimensions of the finished product shall be 9 inches in diameter and

25 feet in length. The minimum weight of the finished product shall be 1.75 lbs./ foot (approximately 35 lbs. per wattle).

B. ESW's shall be installed on specified sites at a rate of approximately 29 wattles/acre (728 linear feet/acre). Vertical spacing of 60 feet between ESW's is an estimate for budgeting purposes, wattle installation on these sites will respond to the presence of specific erosion features. According to the manufacturer's recommendation, for 3:1 slopes (approx. 35% slope), 30-foot spacing is recommended as a general rule of thumb, with a suggestion that closer spacing may be warranted on highly erodible soil types or slopes steeper than 3:1. Cost estimates are based on a unit cost of $1.15/ linear foot ($28.75 per 9 inch wattle). (Source: California Straw Works)

6.1.2.2 Erosion Control and Sediment Retention Wattle- 12 inch diameter.

A. It shall be a machine-produced tube of compacted rice straw and netting. The netting shall consist of seamless, photodegradable, high-density polyethylene and ethyl vinyl acetate and contain ultra-violet inhibitors. The netting shall be filled with compacted rice straw that is Certified Weed Free Forage under California Food and Agriculture Code Section 5101 and 5205. A certificate of weed free status shall be available from the manufacturer. The dimensions of the finished product shall be 12 inches in diameter and 10 feet in length. The minimum weight of the finished product shall be 4 lbs./ foot (approx 40 lbs. per wattle).

B. ESW's shall be installed on specified sites at a rate of approximately 58.5 wattles/acre (1,463 linear feet/acre). Vertical spacing of 30 feet between ESW's is according to the manufacturer's recommendations for installation. For 3:1 slopes (approx. 35%), 30-foot spacing is recommended as a general rule of thumb, with a suggestion that closer spacing may be warranted on highly erodible soil types or slopes steeper than 3:1. Cost estimates are based on a unit cost of $1.49/ linear foot ($14.90 per 12 inch wattle). (Source: California Straw Works)

6.1.2.3 Wood Stakes.

A. Wood stakes are used to fasten the ESW to the soil and anchor it in place to prevent sagging or rolling downhill. Wood stakes shall be dimensioned 1" x 1" x 18" long (9 inch wattle), or 1" x 1" x 24" long (12 inch wattle), with one sharpened end.

B. Cost estimates are based on a unit price of $0.20/ wooden stake.

6.2 Aerial Application of Agricultural Lime- (Bare Areas, Steep Degraded Grasslands, Degraded Grasslands, and Steep Slope Reclamation sites)

6.2.1 Scope Of Work

6.2.1.1 Definition. Liming is a common agricultural technique used to neutralize acidic soil conditions and provide favorable conditions for vegetation establishment and to improve plant growth. An agricultural liming material is defined as a material containing calcium (Ca) and/or magnesium (Mg) compounds capable of neutralizing soil acidity. Calcium carbonate or mixtures of calcium and magnesium carbonate are the most common materials used for liming soils. For steep hillsides or areas with variable terrain, agricultural lime is applied aerially in a slurry form, mixed with a polymer tackifier to help bind the material to steep slopes. This slurry is applied using customized helicopters outfitted with specialized equipment, usually a holding tank combined with a blending apparatus capable of holding and mixing the slurry ingredients. This equipment permits the operator to hydraulically spray the mixture over the site.

6.2.1.2 Technical Feasibility.

A. The Aerial Application of Agricultural Lime is specified to address the need to adjust pH levels in selected soils within the Mount Haggin Injured IA toward neutral (a value of 7). Soils for which analyses have indicated pH levels less than 6 at depth have been identified as requiring treatment and mitigation to allow successful revegetation (EPA 2001). The adjustment of soil pH is necessary to reduce the mobility of copper (Cu), zinc (Zn), lead (Pb), and cadmium (Cd) in soils. Mobilization of metals in the soil by low pH conditions results in an increased risk of phytotoxicity, increased risk of groundwater contamination, and increased risk to aquatic receptors receiving surface water runoff (EPA 2001). This specification will address the modification of soil pH on sites that are considered inaccessible by machinery but nonetheless will require these treatments to enable successful revegetation.

B. Observations and field data collected on the Mount Haggin IA indicate the presence of elevated and phytotoxic levels of metals occurring within surface soils (Montana 1995). It has been determined that these levels have triggered a community-level phytotoxic response which has dramatically reduced native plant cover (Montana 1995). These observations indicate that the Aerial Application of Agricultural Lime is appropriate for selected sites within the IA.

C. The Aerial Application of Agricultural Lime is specified to address soil acidity concerns and to reduce trace element availability in order to facilitate successful revegetation on selected treatment areas within the IA, including BA, SDG, Degraded Grasslands (DG), and SSR sites.

6.2.1.3 Coordination With Remedy.

A. The Aerial Application of Agricultural Lime is specified for BA, SDG, and DG, for which there is currently no proposed remedial action. For remedy sites designated as SSR, the modification of soil pH via liming is not addressed in the proposed remedial action (AERL 2002). Thus, this treatment represents an additional work item for SSR sites.

B. The Aerial Application of Agricultural Lime is specified to occur during the Fall of Year One on BA, SDG, and DG and during the Fall of Year Seven on SSR sites.

6.2.2 Products and Materials

6.2.2.1 Agricultural Lime.

A. The lime product specified for use with this treatment shall be an agricultural-grade dolomitic lime that can be mixed into a slurry to allow for hydraulic application.

B. Dolomitic lime shall be applied on specified sites at a rate of 7.5 tons/acre. Cost estimates are based on a unit cost of $72/ ton of dolomitic lime. (Source: Continental Lime)

6.2.2.2 Tackifiers.

A. The tackifier specified for use with this treatment is a polymer tackifier, such as the product SoilMaster WR or the equivalent, to be incorporated with the lime material specified above.

B. Polymer tackifiers shall be applied to the specified sites at a rate of 70 gals./ acre. Cost estimates are based on a unit price of $6/ gallon for polymer tackifiers. (Source: Revex)

6.2.2.3 Helicopter Spreader.

A. The equipment specified for use with this treatment shall be a helicopter outfitted with a holding tank combined with a blending apparatus capable of holding and mixing the slurry ingredients.

B. Cost estimates are based on a unit price of $4,446.41/ acre of helicopter liming. (Source: Erickson Air Crane).

6.3 Aerial Seeding- (Bare Areas, Steep Degraded Grasslands, Degraded Grasslands sites)

6.3.1 Scope Of Work

6.3.1.1 Definition. Aerial seeding is a form of broadcast seeding that is commonly used in agriculture, reforestation, and the rehabilitation of large, burned areas. It involves the use of either fixed-wing aircraft or helicopters outfitted with specialized broadcasting equipment to spread a dry mixture of seed efficiently over large areas, without damage to existing vegetation on the site. This technique is generally suited for inaccessible areas with gentle to moderate slopes.

6.3.1.2 Technical Feasibility.

A. This treatment is specified to address the need to establish a self-sustaining, dense cover of native grasses on steep, inaccessible sites for the purposes of long-term, sustainable erosion control, soil stabilization, and habitat enhancement. The use of this treatment assumes that a measure of overall site stability has been achieved on steep slope areas through other means such as the installation of ESW (**Specification 6.1**). Erosion controls such as those specified will serve only to temporarily prevent the offsite transport of surficial runoff and sediment, while not adequately addressing the cause and source of such sediment transport. Thus, vegetation establishment is needed to solve the sediment problem for the long-term. The agents that cause such surface erosion are wind, water, and ice acting upon unprotected (bare) soils. The prescribed seeding treatment will address the source of these erosion concerns by establishing a dense coverage of native grasses on these sites. A tight, dense cover of grass or herbaceous vegetation provides one of the best protections against surficial rainfall and wind erosion because they absorb rainfall energy, prevent soil detachment, filter sediment from runoff, increase surface roughness and slow runoff velocities, and maintain soil porosity and permeability (Gray and Sotir 1996). Furthermore, this seeding treatment is prescribed in order to meet the restoration goals of establishing a native vegetation cover that is similar in composition and structure to baseline conditions observed at the RA.

B. Observations and field data collected on the Mount Haggin IA indicates that vegetation occurring on BA and Grasslands is variable, but consistently low in canopy cover. Large areas of unstable soil occur and contribute to soil erosion. On BA, an average of 74% of the area per polygon was noted as lacking vegetation. On Grassland sites, an average of 54.7% of the area per polygon was noted as lacking vegetation. These observations indicate that Aerial Seeding is appropriate for selected sites within the IA.

C. For steep and variable mountainous terrain, helicopter seeding is the most appropriate application method due to the versatility and maneuverability of the equipment. This Plan specifies the use of helicopter seeding for selected treatment areas of the IA, including BA, SDG, and DG. Under the Active Restoration Alternative, this treatment is also specified for SSR sites.

6.3.1.3 Coordination With Remedy.

A. Aerial Seeding is specified for BA, SDG, and DG, for which there is currently no proposed remedial action. For remedy sites designated as SSR, the establishment/ enhancement of an adequate grass cover is not addressed in the proposed remedial action. Thus, this treatment represents an additional work item for SSR sites.

B. Aerial Seeding is specified to occur during the Spring of Year Two.

6.3.2 Products and Materials

6.3.2.1 Native Seed Mix.

A. The seed mix specified for use with this treatment shall consist of native grass and forb species from an appropriate local or regional seed source. Selected species shall include dominant species representative of early- and mid-successional phases of the individual native habitat types to be restored (**Table 6.3.2.1.1**).

B. Native grass and forb seed shall be applied to specified sites at a rate of 40 pounds/acre. Cost estimates are based on a unit cost of $18/ pound of native grass and forb seed. (Source: Granite Seed)

C. A typical seed mix for Aerial Seeding on specified sites of the Mount Haggin IA is as follows:

Table 6.3.2.1.1. Typical seed mix for all treatment areas.

Grasses		% mix
Bluebunch Wheatgrass	*Agropyron spicatum 'Goldar'*	15.0%
Sheep Fescue	*Festuca ovina 'Durar'*	15.0%
Basin Wildrye	*Elymus cinereus 'Trailhead'*	15.0%
Bottlebrush Squirreltail	*Sitanion hystrix*	15.0%
Tufted Hairgrass	*Deschampsia cespitosa*	15.0%
Sandberg bluegrass	*Poa sandbergii (P. secunda)*	15.0%
	Subtotal	**90.0%**
Forbs		
Fireweed	*Epilobium angustifolium*	3.0%
Rocky Mountain Penstemon	*Penstemon strictus*	1.0%
Blue Flax	*Linum lewisii*	1.0%
Arrowleaf Balsamroot	*Balsamorhiza sagittata*	1.0%
Lacy Phacelia	*Phacelia tenacetifolia*	1.0%
	Subtotal	**7.0%**
Legumes		
Lupine	*Lupinus argenteus*	1.0%
Alfalfa	*Medicago sativa 'Ladak'*	1.0%
Hairy Vetch	*Vicia villosa*	1.0%
	Subtotal	**3.0%**
	Grand Totals	**100.0%**

6.3.2.2 Helicopter Spreader.

A. The equipment specified for use with this treatment shall be a dry slung fertilizer or seed bucket similar to an Isolair 2600-45H or the equivalent. The seed bucket shall be suspended from a helicopter capable of supporting the bucket fully loaded (approx. 2500 lbs.).

B. Cost estimates are based on a unit price of $195.16/ acre for aerial seeding. (Source: Minuteman Aviation)

6.4 Aerial Application of Hydromulch- (Bare Areas)

6.4.1 Scope Of Work

6.4.1.1 Definition. The term hydromulch refers to a combination of water, mulch, and tackifier (a type of organic polymer or glue-like substance) that is sprayed on a disturbed site after seeding. Hydromulches are applied to soils primarily to bind newly applied seed to the soil, reduce surficial erosion, reduce evapotranspiration from the soil surface, reduce soil surface temperatures, and prevent soil crusting. Erosion control elements of the mix, such as virgin wood fiber mulch and tackifiers, can provide benefits for up to one year after application. The Aerial Application of Hydromulch involves the use of customized helicopters outfitted with specialized equipment, usually a holding tank combined with a blending apparatus capable of mixing the ingredients into a slurry. This equipment permits the operator to hydraulically spray the mixture over the site. The ability of hydromulch to disperse mulch, fertilizers, and tackifiers simultaneously contributes to the economy of operation of these machines in large-scale operations.

6.4.1.2 Technical Feasibility.

A. This treatment is specified in combination with the Aerial Seeding (**Specification 6.3**) on steep sites (>35% slope), in order to address the need to bind newly applied seed to the soil surface, protect the seed from erosion, and to enhance germination. This seeding method is commonly referred to as the "two-pass method" in which seed is applied during the "first pass" and hydromulch is applied on top of the seed during the "second pass." In addition to mulch materials, fertilizers may also be incorporated into the slurry and applied simultaneously (**Specification 6.5**).

B. Field observations and data collected on sites within the Mount Haggin IA indicate all BA and SDG exhibit varying degrees of sheet, rill, or gully erosion. Typically, 62% of an area designated as Bare exhibits sheet erosion. Likewise, 38% of an area designated as Grassland exhibits sheet erosion. These observations indicate that Aerial Seeding is appropriate for selected sites within the IA. Refer to **Section 4** for a full discussion of these field observations and collected data.

C. For steep and variable mountainous terrain, aerial hydromulching via helicopter is the most appropriate method due to the versatility and maneuverability of the equipment. This Plan specifies the Aerial Application of Hydromulch for all BA of the IA. Under the Active Restoration Alternative, this treatment is also specified for SSR sites.

6.4.1.3 Coordination With Remedy.

A. The Aerial Application of Hydromulch is a companion treatment to Aerial Seeding (**Specification 6.3**) and is specified for BA, for which there is currently no proposed remedial action. For remedy sites designated as SSR, the establishment/ enhancement of an adequate grass cover (and similarly, the need for hydromulch) is not addressed in the proposed remedial action. Thus, this treatment represents an additional work item for SSR sites.

B. The Aerial Application of Hydromulch is specified to occur during the Spring of Year Two, immediately following Aerial Seeding.

6.4.2 Products and Materials

6.4.2.1 Mulch.

A. The mulch materials specified for use with this treatment shall consist of virgin wood fiber mulch typical to that used in the hydroseeding industry, such as the product "EcoFibre" or the equivalent.

B. Mulch shall be applied to the specified sites at a rate of 1 ton/ acre. Cost estimates are based on a unit price of $320/ ton for mulch materials. (Source: FMI/Kopp)

6.4.2.2 Tackifiers.

A. The tackifiers specified for use with this treatment include a combination of materials to be incorporated with the mulch materials specified above. Tackifiers shall include fibrous tackifier, such as the product "Finnfibers" or the equivalent, polymer tackifier, such as the product "SoilMaster WR" or the equivalent, and a guar tackifier.

B. Fibrous tackifiers shall be applied to the specified sites at a rate of 30 lbs./ acre. Polymer tackifiers shall be applied to the specified sites at a rate of 70 gals./ acre. Guar tackifiers shall be applied to the specified sites at a rate of 50 lbs./ acre. Cost estimates are based on a unit price of $6/ gallon for polymer tackifiers, $2.50/ pound for fibrous tackifiers, and $1.70/ pound for guar tackifiers. (Source: FMI/Kopp and Revex)

6.4.2.3 Helicopter Hydromulcher.

A. The equipment specified for use with this treatment shall be a helicopter outfitted with a holding tank combined with a blending apparatus capable of holding and mixing the slurry ingredients.

B. Cost estimates are based on a unit price of $3,116.81/ acre of helicopter hydromulching. (Source: Erickson Air Crane)

6.5 Aerial Application of Fertilizers- Initial Rate- (all sites)

6.5.1 Scope Of Work

6.5.1.1 Definition. The application of sustained-release, organic-based fertilizers to disturbed sites will facilitate short-term native plant establishment and growth and will regenerate the plant-soil communities and processes that sustain vegetative growth indefinitely. The specified fertilizer products are characterized by a moderate initial release of nitrogen (N) and slower long-term N release from the decomposition of organic materials and blends. The specified products are available in dry, pelletized form and can be applied using either fixed-wing aircraft or helicopters outfitted with specialized broadcasting equipment, or as a component of a slurry application of hydromulch (**Specification 6.4**). These techniques are generally suited for inaccessible areas with moderate to steep slopes.

6.5.1.2 Technical Feasibility.

A. This treatment is specified to address the regeneration of soil health and fertility in order to support (restore) a healthy stand of self-sustaining native vegetation. Disturbed sites must undergo primary succession and soil regeneration before they can support plant cover similar to adjacent vegetated areas. Studies indicate that plant growth on degraded soils is often nutrient limited, and that low soil nitrogen (N) is the most common limiting element (other than water) (Claassen and Hogan 1998). Poor soil fertility and physical characteristics can only be sustainably remediated by consistent plant growth on the site, indicating the need to apply fertilizers (supplemental N sources) to disturbed sites to support plant growth and improve soil structure. Sustained plant growth is also expected to generate secondary beneficial effects, including deposition of erosion resistant mulch layers, addition of moisture retaining soil organic matter, regeneration of pools of plant available nutrients, and the generation of water-stable soil aggregates. Soluble N amendments from standard agricultural fertilizers are incompatible with the goals of re-establishing native vegetation as these products are characterized by a rapid release of nutrients that have been shown to favor the growth of weedy annuals and exotic vegetation, to the detriment of establishing native vegetation (Claassen and Hogan 1998). The specified fertilizer products are compatible with the goals of establishing native vegetation as the relatively lower short term N availability restricts weedy invasion while the large, organically stabilized reserve provides continued N release for multiple years.

B. Field observations and data collected on sites within the Mount Haggin IA indicate that the loss of topsoil and organic matter are indicative of the loss of soil fertility. These observations indicate that the Aerial Application of Fertilizers is appropriate for selected sites within the IA. Soil sampling and nutrient analysis should be conducted in order to develop site-specific fertilization plans.

C. For steep and variable mountainous terrain, helicopter application of fertilizers is the most appropriate method due to the versatility and maneuverability of the equipment. This Plan specifies the Aerial Application of Fertilizers for selected treatment areas of the IA, including BA, SDG, and DG. Under the Active Restoration Alternative, this treatment is also specified for SSR sites.

6.5.1.3 Coordination With Remedy.

A. The Aerial Application of Fertilizers is specified for BA, SDG, and DG, for which there is currently no proposed remedial action. For remedy sites designated as SSR, fertilization as a method to enhance the quality of ground cover vegetation is not addressed in the proposed remedial action (AERL 2002). Thus, this treatment represents an additional work item for SSR sites.

B. The Aerial Application of Fertilizers is specified to occur immediately following Aerial Seeding (**Specification 6.3**) during the Spring of Year Two on BA, SDG, and DG areas during the Spring of Year Eight on SSR.

6.5.2 Products and Materials

6.5.2.1 Slow-Release Organic Fertilizer.

A. The fertilizer products specified for use with this treatment shall consist of a pelletized, organic-based, slow-release fertilizer such as the product "Biosol Mix (7-2-3)" or the equivalent.

B. Fertilizer shall be applied to the specified sites at an initial rate of 1 ton/ acre. Cost estimates are based on a unit price of $540/ ton for fertilizer. (Source: Rocky Mountain BioProducts)

6.5.2.2 Helicopter Spreader.

A. A Helicopter Spreader will be used to apply fertilizer to sites that will not be receiving a hydromulch treatment (**Specification 6.4**), specifically SDG and DG. The equipment specified for use with this treatment shall be a dry slung fertilizer or seed bucket similar to an Isolair 2600-45H or the equivalent. The seed bucket shall be suspended from a helicopter capable of supporting the bucket fully loaded (approx. 2500 lbs.).

B. Cost estimates are based on a unit price of $195.16/ acre for aerial fertilizer application. (Source: Minuteman Aviation)

6.5.2.3 Helicopter Hydromulcher.

A. For those sites that will be receiving a hydromulch treatment (BA and SSR sites), it is assumed that the Aerial Application of Fertilizers- Initial Rate would be implemented simultaneously along with Aerial Application of Hydromulch (**Specification 6.4**) and would utilize the same equipment as specified for that purpose.

B. Costs for the Aerial Application of Fertilizers- Initial Rate are included in the cost provided for the Aerial Application of Hydromulch (**Specification 6.4**).

6.6 Aerial Application of Compost- (Bare Areas, Steep Degraded Grasslands and Degraded Grasslands, under the Active Restoration Alternative)

6.6.1 Scope Of Work

6.6.1.1 Definition. The Aerial Application of Compost refers to the broadcast application of organic compost that has been formed into lightweight pellets. Organic compost is derived from the biological decomposition of plant and organic waste materials and is typically added to disturbed soils in order to improve rootzone properties and to promote the microorganisms necessary to establish healthy nutrient cycles. The aerial application of compost will provide a one-fourth inch layer of organic material added to the surface of selected disturbed soils within the IA. This layer of organic matter will simulate an organic soil horizon typical of undisturbed soils and will provide long-term nutrient availability and a favorable growth media to restored vegetation.

6.6.1.2 Technical Feasibility.

A. This treatment is specified to address the need to restore soil health and structure to disturbed areas. Proper soil structure, in this case, a structure similar to adjacent undisturbed native communities, is a prerequisite to supporting a self-sustaining cover of restored native vegetation. The addition of compost and other organic amendments (in this case, a surface application similar to mulch) to disturbed soils has been shown to provide surficial erosion resistance, reduce evaporation of soil moisture, provide favorable conditions for seed germination, and neutralize acid soils (Munshower 1994). Organic compost provides both short- and long-term benefits to newly established vegetation as it contains small quantities of nitrogen, phosphorus, and other plant nutrients. It also forms an energy source (carbon compounds) for many decomposer soil organisms such as bacteria, fungi, and other soil microbes that generate and maintain soil structure (Munshower 1994).

B. Field observations and data collected on sites within the Mount Haggin IA indicate that all Bare and many Grassland sites lacked organic matter due to extensive erosion. Lack of organic matter results in a loss of soil fertility, moisture retention, and surface texture conducive to seed germination. Those areas identified as Bare on the Keammerer vegetation map are assumed to have lost organic matter and thus the potential to revegetate. Also, areas identified as Grasslands varied from highly eroded to highly vegetated, indicating the loss of organic matter on some sites. These observations indicate that the Aerial Application of Compost is appropriate for selected sites within the IA.

C. For steep and variable mountainous terrain, helicopter application of pelletized compost is the most appropriate method due to the versatility and maneuverability of the equipment. This Plan specifies Aerial Compost Application by helicopters under the Active Restoration Alternative, for selected treatment areas of the IA, including BA, SDG, and DG.

6.6.1.3 Coordination With Remedy.

A. The Aerial Application of Compost is specified under the Active Restoration Alternative for BA, SDG, and DG, for which there is currently no proposed remedial action.

B. The Aerial Application of Compost is specified to occur during the Spring of Year Three.

6.6.2 Products and Materials

6.6.2.1 Pelletized Compost.

A. The compost products specified for use with this treatment shall consist of pelletized, organic compost such as that available from "Glacier Gold" or the equivalent.

B. Pelletized compost shall be applied to the specified sites at a rate of 34 cubic yards/ acre. Cost estimates are based on a unit price of $72.90/ cubic yard for pelletized (bulk) compost. (Source: Glacier Gold)

6.6.2.2 Helicopter Broadcaster.

A. The equipment specified for use with this treatment shall be a dry slung fertilizer or seed bucket similar to an Isolair 2600-45H or the equivalent. The seed bucket shall be suspended from a helicopter capable of supporting the bucket fully loaded (approx. 2500 lbs.).

B. Cost estimates are based on a unit price of $3,197.21/ acre for aerial compost application. (Source: Minuteman Aviation)

6.7 Restoration Enhancement Planting- (all sites, under the Active Restoration Alternative)

6.7.1 Scope Of Work

6.7.1.1 Definition. Restoration Enhancement Planting refers to the planting of containerized native plant materials as a component of an overall restoration strategy. This treatment is specified as a means to achieve a greater density and diversity of native woody, grass, and forb species on sites that have been previously reclaimed or that have been seeded and planted as part of the proposed remedial actions. Hand planting containerized plant materials is the preferred method of implementing restoration enhancement plantings and is the most common method of planting containerized plant materials in the revegetation, reforestation, and restoration industries. A variety of species mixes will be developed for various sites based upon the habitat type to be restored.

6.7.1.2 Technical Feasibility.

A. Restoration Enhancement Planting is specified as a means to more adequately restore sites within the IA to baseline conditions. The specified Restoration Enhancement Plantings will consist of mid- successional species appropriate to the habitat types to be restored. This will be achieved by hand planting containerized woody, grass, and forb plants to augment other proposed restoration actions such as seeding and Noxious Weed Control (**Specification 6.13**). Hand planting utilizes tools such as hoedads and shovels to install plant materials in a naturalistic pattern that responds to the physical and environmental conditions of the planting site. At the time of planting, each plant will receive an additional fertilizer and compost treatment. Specifically, a fertilizer packet and a pint of pelletized compost will be incorporated into each planting hole prior to installing the seedling. Hand planting is appropriate for all sites within the IA but is especially appropriate for remote, steep, and/or inaccessible sites that preclude the use of mechanical (tractor-drawn) planters such as those used in agriculture.

B. Field observations and data collected on sites within the Mount Haggin IA indicate that sites designated for restoration efforts are typically dominated by metal tolerant species such as redtop, basin wildrye, or noxious weed species such as spotted knapweed, leafy spurge, or Canada thistle. These species are typical of a stressed or degraded condition in which COC levels or eroding soil conditions determine the dominant vegetation. These observations indicate that Restoration Enhancement Planting is appropriate for selected sites within the IA.

C. Restoration Enhancement Plantings are specified under the Active Restoration Alternative for selected treatment areas of the IA, including BA, SDG, DG and Impacted Grasslands (IG) sites.

6.7.1.3 Coordination With Remedy.

A. Restoration Enhancement Planting is specified under the Active Restoration Alternative for BA, SDG, and DG, for which there is currently no proposed remedial action. This treatment is also specified under the Active Restoration Alternative for SSR and IG sites. For SSR sites, the proposed remedial action includes PTSG at a target density of approximately 500 stems/acre (AERL 2002). This treatment seeks to increase this planting density by an additional 500 stems/acre, and to increase the diversity of species planted. The proposed treatment can be implemented simultaneously with the proposed remedial action (PTSG). For IG sites, the proposed remedial action does not include planting as a means to increase the diversity and cover of native vegetation. Thus, this treatment represents an additional work item for IG sites.

B. Restoration Enhancement Planting is specified to occur during the Spring of Years Three through Six on BA, Steep Grasslands (SG), SDG, and IG sites and during the Spring of Years Nine through Twelve on SSR sites.

6.7.2 Products and Materials

6.7.2.1 Containerized Plant Materials.

A. The containerized plant materials specified for use with this treatment shall be 10 cubic inch seedlings or the equivalent size, propagated in a rigid container such as a "Super-Cell" as manufactured by Steuwe & Sons or Corvallis, OR, or the equivalent. In certain instances (e.g. grass plugs), smaller containers may be used at reduced cost but increased density. Seedlings shall be propagated from an appropriate local or regional seed source. Selected species shall include dominant species representative of mid-successional phases of the individual native habitat types to be restored (**Table 6.7.2.1.1**). Seedlings shall be hardened-off to ambient temperatures and sun exposure for a minimum of two weeks prior to planting.

B. A planting density of 500 plants/acre (approximately 9 foot spacing) is specified, consisting of a minimum of five mid-successional species representative of the habitat types to be restored. This specification is intended to address both the need for adequate density and cover of native vegetation and the desire for a minimum diversity of native species for habitat enhancement. Cost estimates are based on a unit cost of $1.15/ plant for containerized seedlings. (Source: Bitterroot Restoration)

C. A list of desirable native species for Restoration Enhancement Planting on specified sites of the Mount Haggin IA is as follows:

Table 6.7.2.1.1. Desirable native species for Restoration Enhancement Planting.

Trees	
Douglas fir	*Pseudotsuga menziesii*
Engelmann Spruce	*Picea engelmannii*
Limber Pine	*Pinus flexilis*
Lodgepole pine	*Pinus contorta*
Rocky Mountain Juniper	*Juniperus scopulorum*
Shrubs	
Alder	*Alnus sinuata*
Bitterbrush	*Purshia tridentata*
Chokecherry	*Prunus virginiana*
Common Juniper	*Juniperus communis*
Creeping Juniper	*Juniperus horizontalis*
Grouse Whortleberry	*Vaccinium scoparium*
Horsebrush	*Tetradymia canescens*
Oregon grape	*Berberis repens*
Russet Buffaloberry	*Shepherdia canadensis*
Scouler's Willow	*Salix scouleriana*
Serviceberry	*Amelanchier alnifolia*
Snowberry	*Symphoricarpos sp.*
Spirea	*Spirea betulifolia*
Winterfat	*Ceratoides lanata*
Wood's Rose	*Rosa woodsii*

6.7.2.2 Slow-release Fertilizer Packet.

A. The fertilizer packet specified for use with this treatment shall consist of a slow-release fertilizer product encased in a biodegradable packet or "teabag" such as a "Bio-Pak (16-6-8+minors)" or the equivalent.

B. One fertilizer packet shall be installed with each planted seedling. The individual packet shall be placed in the bottom of the planting hole prior to the installation of the seedling. Cost estimates are based on a unit cost of $0.06/ packet of slow-release fertilizer. (Source: RTI)

6.7.2.3 Pelletized Compost.

A. The compost products specified for use with this treatment shall consist of pelletized, organic compost such as that available from "Glacier Gold" or the equivalent.

B. Pelletized compost shall be incorporated into the soil of each planting hole at rate of 1 pint (.000619 cubic yards)/ hole. Cost estimates are based on a unit price of $83.70/ cubic yard for pelletized (and bagged) compost. (Source: Glacier Gold)

6.7.2.4 Hand Planting.

A. The method specified for implementation of this treatment shall be hand planting using hand tools such as hoedads or the equivalent.

B. Cost estimates are based on unit prices of $2.98/ seedling (including amendments and plant protector installation) for hand planting. (Source: Bitterroot Restoration)

6.8 Install Plant Protectors- (all sites, under the Active Restoration Alternative)

6.8.1 Scope Of Work

6.8.1.1 Definition. Plant Protectors are tubes constructed of rigid plastic, cardboard, or netting that are placed around a newly planted seedling in order to protect the young plants from adverse environmental conditions and/or herbivory. Plant protectors are typically left in place until the plant has become established, is climate hardy, and can tolerate a moderate level of browse, usually one or two seasons. Selection of the appropriate protection device typically depends upon site-based environmental factors, type of browse protection required, cost considerations, product life and plant growth form.

6.8.1.2 Technical Feasibility.

A. The specified Plant Protectors will address the need for herbivory protection and microsite enhancement for all container plants installed as part of the Restoration Enhancement Planting specification (**Specification 6.7**). Plant Protectors shelter the seedling, improve the microsite condition of the planting location, and improve growth rates (Meyer 1992, Windell 1991). Excessive herbivory of newly installed seedlings will increase plant mortality by removing large portions of actively growing stems and leaves, and can even pull the entire plant out of the ground. An appropriate protection device will exclude grazing animals, allowing the plants to mature to a point where they have the ability to recover from a moderate level of browse. Environmental factors can also have a significant impact on seedling survival. Left unprotected, seedlings are subjected to extremes of temperature and can suffer the effects of unseasonal frost or scalding from excessive heat. Winds can prematurely dry out the seedling or, in erosion prone or bare areas, can "sandblast" the plant with windblown soils and debris. The specified products, being constructed of rigid plastic walls, also act as a miniature greenhouse, serving to trap heat, condense moisture, and even accumulate snow, which will later provide additional moisture to the establishing plant. An initial investment in Plant Protectors can lessen the need for extensive replacement plantings.

B. Field observations and data collected on sites within the Mount Haggin IA indicate that the occurrence of browse is highly variable but that a significant level of browse could be expected, especially as palatable native species are restored to poorly vegetated sites. Refer to **Section 4** for a full discussion of these field observations and collected data.

C. The Installation of Plant Protectors is a companion specification to Restoration Enhancement Planting (**Specification 6.7**) and is specified under the Active Restoration Alternative for all treatment areas of the IA, including BA, SDG, DG, SSR and IG sites.

6.8.1.3 Coordination With Remedy.

A. The Installation of Plant Protectors is a companion specification to Restoration Enhancement Planting (**Specification 6.7**) and as such, is specified under the Active Restoration Alternative for BA, SDG, and DG, for which there is currently no proposed remedial action. This treatment is also specified under the Active Restoration Alternative for SSR and IG sites. The proposed remedial action for these sites does not include the addition of plant protectors on newly installed plantings (on SSR sites), although it is recommended. This Plan specifies the use of plant protectors on all plantings specified under this Plan, and does not address the addition of plant protectors for plantings proposed as part of the remedial action. This treatment represents an additional work item for SSR and IG sites.

B. The Installation of Plant Protectors is specified to occur during the Spring of Years Three through Six on BA, SG, SDG, and IG sites and during the Spring of Years Nine through Twelve on SSR sites immediately following Restoration Enhancement Planting.

6.8.2 Products and Materials

6.8.2.1 Plant Protectors and Pine Stakes.

A. The plant protectors specified for use with this treatment shall consist of a 12 inches tall x 4 inches in diameter corrugated, single-wall polyethylene tube such as a "Tree-Pro Jr." or the equivalent. Each plant protector shall be fastened to a pine stake with a ratcheting plastic zip tie. The pine stake shall be driven into the soil to a depth of approximately 8-10 inch adjacent to the planted seedling in order to securely anchor the protector in an upright fashion. Pine stakes shall be manufactured of untreated pine, with dimensions of ¾" x ¾" x 22", and pointed on one end.

B. One plant protector, one zip tie, and one pine stake shall be installed around each planted seedling. Cost estimates are based on a unit cost of $0.46/ protector (including tie and stake). (Source: TreePro and Opportunity Resources)

6.8.2.2 Installation of Plant Protectors.

A. The method specified for implementation of this treatment shall be hand labor.

B. Cost estimates for plant protector installation are included in the cost estimate provided for Hand Planting (**Specification 6.7.2.4**).

6.9 Aerial Application of Fertilizers- Maintenance Rate- (Bare Areas, Steep Degraded Grasslands and Degraded Grasslands)

6.9.1 Scope Of Work

6.9.1.1 Definition. The Aerial Application of Fertilizers at a Maintenance Rate refers to a follow up application of sustained-release, organic-based fertilizers to replenish nutrient reserves in the soil following initial establishment of restored vegetation. Repeated application of organic-based fertilizers will effectively build nutrient resources, both short-term soluble reserves and long-term stabilized reserves, in the soil to the levels required to sustain vegetative growth for the long term. The specified products and application methods are identical to those described for the Aerial Application of Fertilizers (**Specification 6.5**).

6.9.1.2 Technical Feasibility.

A. This application is specified in order to increase the amounts of plant available nitrogen (N) in soils following the initial establishment of restored vegetation. The specified fertilizer products are characterized by a moderate initial release of nitrogen (N) and slower long-term N release from the decomposition of organic materials and blends. After the initial release of N has been incorporated into the plant tissues of newly established vegetation, additional N inputs are required to sustain other beneficial soil processes that are important to the effective restoration of disturbed sites (Claassen and Hogan 1998). These processes include stimulating the decomposition of litter residues, facilitating the development of extensive root systems, and supporting greater populations of soil microbes. An in-depth discussion of the benefits of fertilization is provided in **Specification 6.5**.

B. Field observations and data collected on sites within the Mount Haggin IA indicate that the lack of organic matter and plant growth on certain sites is indicative of inadequate soil fertility. Data in the form of field soil sampling and nutrient analysis will be required to appropriately apply this specification, but observations indicate that the Aerial Application of Maintenance Fertilizers is appropriate for the selected sites.

C. The Aerial Application of Maintenance Fertilizers is specified to occur four years after the initiation of Restoration Enhancement Planting (**Specification 6.7**) under both the Stabilization and Active Restoration Alternatives for selected treatment areas of the IA, including BA, SDG, and DG.

6.9.1.3 Coordination With Remedy.

A. The Aerial Application of Maintenance Fertilizers is specified for BA, SDG, and DG, for which there is currently no proposed remedial action.

B. The Aerial Application of Maintenance Fertilizers is specified to occur during the Spring of Year Six, four years after the initiation of Restoration Enhancement Planting.

6.9.2 Products and Materials

6.9.2.1 Slow-Release, Organic Fertilizer.

A. The fertilizer products specified for use with this treatment shall consist of a pelletized, organic-based, slow-release fertilizer such as the product "Biosol Mix (7-2-3)" or the equivalent.

B. Fertilizers shall be applied to the specified sites at a maintenance rate of one-half ton/ acre. Cost estimates are based on a unit price of $540/ ton for fertilizers. (Source: Rocky Mountain BioProducts)

6.9.2.2 Helicopter Broadcaster.

A. The equipment specified for use with this treatment shall be a dry slung fertilizer or seed bucket similar to an Isolair 2600-45H or the equivalent. The seed bucket shall be suspended from a helicopter capable of supporting the bucket fully loaded (approx. 2500 lbs.).

B. Cost estimates are based on a unit price of $224.43/ acre for aerial fertilizer application. (Source: Minuteman Aviation)

6.10 Maintenance of Erosion Control and Sediment Retention Wattles (ESW)-

(Bare Areas and Steep Degraded Grasslands)

6.10.1 Scope Of Work

6.10.1.1 Definition. The Maintenance of Erosion Control and Sediment Retention Wattles (ESW) refers to the periodic re-anchoring or replacement of any ESW's that may have been displaced or compromised by environmental factors such as continuing erosion or snow loading. This maintenance can be performed simultaneously with Restoration Monitoring (**Specification 6.14**) and will be an opportunity to evaluate the effectiveness of ESW placement and the extent to which surficial erosion has been controlled and sediments retained or stabilized by established vegetation. A detailed description of Erosion Control and Sediment Retention Wattles is presented in **Specification 6.1**.

6.10.1.2 Technical Feasibility.

A. The use of ESW's is specified to address the need to stabilize steep, eroding slopes prior to the implementation of soil amendments and revegetation treatments. A more detailed description of these benefits is provided in **Specification 6.1**. Maintenance of Erosion Control and Sediment Retention Wattles is essential to ensure that these benefits continue to be provided until such time as the restored vegetation is well established. Established vegetation will provide a long-term solution to these erosion concerns by performing the functions of providing slope stability and surface cover adequate to protect soils from the erosive forces of water and wind.

B. Maintenance of Erosion Control and Sediment Retention Wattles is appropriate for selected sites within the IA for which ESW installation is specified (**Specification 6.1**).

C. Maintenance of Erosion Control and Sediment Retention Wattles is specified for all sites where ESW's will be installed (**Section 6.1**). This includes selected treatment areas within the IA with a slope greater than 35% (BA and SDG).

6.10.1.3 Coordination With Remedy.

A. The Maintenance of Erosion Control and Sediment Retention Wattles is a companion specification to the installation of Erosion Control and Sediment Retention Wattles (**Specification 6.1**) and as such, is specified for BA and Steep Degraded Grassland sites, for which there is currently no proposed remedial action.

B. The Maintenance of Erosion Control and Sediment Retention Wattles is specified to occur during the Summer of Years Two and Three.

6.10.2 Products and Materials

6.10.2.1 Wood Stakes.

A. Replacement or additional wood stakes shall be used as needed to fasten the ESW to the soil and anchor it in place if it has sagged or rolled downhill. In some cases, the trench in which the ESW's are placed may need to be re-excavated and the ESW reseated snugly into the soil prior to staking. Wood stakes shall be dimensioned 1" x 1" x 18" long (9 inch wattle), or 1" x 1" x 24" long (12 inch wattle), with one sharpened end.

B. Cost estimates are based on a unit price of $0.20/ wooden stake.

6.11 Maintenance of Plant Protectors- (all sites, under the Active Restoration Alternative)

6.11.1 Scope Of Work

6.11.1.1 Definition. The Maintenance of Plant Protectors refers to the periodic readjustment or replacement of any protectors that may have been displaced or removed by environmental factors such as wind or snow loading. In addition, the Maintenance of Plant Protectors may include the removal of protectors from those plants that exhibit vigorous growth and are either inhibited by the presence of the protector, or have matured to a point where the protectors no longer provide benefit to the plant. This maintenance can be performed simultaneously with Restoration Monitoring (**Specification 6.14**) and will be an opportunity to identify the extent of plant mortality and the need for Replacement Plant Installation (**Specification 6.12**). A detailed description of Plant Protectors is presented in **Specification 6.8**.

6.11.1.2 Technical Feasibility.

A. The use of Plant Protectors is specified to provide herbivory protection and microsite enhancement benefits to newly planted seedlings on restoration sites. A more detailed description of these benefits is provided in **Specification 6.8**. Maintenance of Plant Protectors is essential to ensure that these benefits continue to be provided to newly planted seedlings until such time as they are well established and matured to a point where they no longer require such protection.

B. Field observations and data collected on sites within the Mount Haggin IA indicate that the Installation of Plant Protection Devices is appropriate for all sites within the IA for which Restoration Enhancement Planting is specified (**Specification 6.7**). Similarly, the maintenance of those Plant Protectors is appropriate for these areas as well.

C. Maintenance of Plant Protectors is specified for all sites where plant protection devices will be installed (**Section 6.8**) as a companion treatment to Restoration Enhancement Planting (**Section 6.7**). Under the Active Restoration Alternative, these sites include all treatment areas of the IA (BA, SDG, DG, SSR and IG sites).

6.11.1.3 Coordination With Remedy.

A. The Maintenance of Plant Protectors is a companion specification to the Installation of Plant Protectors (**Specification 6.8**) and as such, is specified under the Active Restoration Alternative for BA, SDG, and DG, for which there is currently no proposed remedial action. This treatment is also specified under the Active Restoration Alternative for SSR and IG sites. The proposed remedial action for these sites does not include the addition of plant protectors (and, likewise, the maintenance of those protectors) on newly installed plantings (on SSR sites), although it is recommended. This Plan specifies the use of plant protectors on all plantings specified under this Plan, and does not address the addition of plant protectors for plantings proposed as part of the remedial action. This treatment represents an additional work item for SSR and IG sites.

B. The Maintenance of Plant Protectors is specified to occur during the Summer of Years Four through Eight on BA, SG, SDG, and IG sites and during the Summer of Years Ten through Fourteen on SSR sites.

6.11.2 Products and Materials

6.11.2.1 Plant Protectors and Pine Stakes.

A. The plant protectors specified for use with this treatment shall consist of a 12 inches tall x 4 inches in diameter corrugated, single-wall polyethylene tube such as a "Tree-Pro Jr." or the equivalent. Each plant protector shall be fastened to a pine stake with a ratcheting plastic zip tie. The pine stake shall be driven into the soil to a depth of approximately 8 - 10 inches adjacent to the planted seedling in order to securely anchor the protector in an upright fashion. Pine stakes shall be manufactured of untreated pine, with dimensions of ¾" x ¾" inch x 22", and pointed on one end.

B. One plant protector, one zip tie, and one pine stake shall be installed around each planted seedling. Cost estimates are based on a unit cost of $0.46/ protector (including tie and stake). (Source: TreePro and Opportunity Resources)

6.11.2.2 Maintenance of Plant Protectors.

A. The method specified for implementation of this treatment shall be hand labor.

B. Cost estimates for maintaining plant protectors are estimated as 10% of the original costs of planting and plant protector installation (**Specification 6.7.2.4**). The actual quantity of plant protectors to be maintained or replaced will be based upon the results of Restoration Monitoring (**Specification 6.14**).

6.12 Replacement Plant Installation

6.12.1 Scope Of Work

6.12.1.1 Definition. Replacement Plant Installation refers to the replanting of containerized plant materials that may have died following the initial Restoration Enhancement Planting (**Specification 6.7**) efforts and therefore failed to establish the target density and coverage of restored vegetation. Replacement Plant Installation will address any failures in restoration plantings due to environmental extremes, non-viable species selections, excessive browse, or other factors identified during Restoration Monitoring (**Section 6.14**). Replacement plantings may replicate the species mixes originally planted in order to ensure the diversity targets are met, or may be informed by the monitoring results and target those species that have been shown to establish well on these sites.

6.12.1.2 Technical Feasibility.

A. The need for this treatment will rely upon the information gained during Restoration Monitoring efforts (**Specification 6.14**). Replacement Plant Installation will occur on specific sites as necessary in order to ensure that the restoration goals for native species diversity and density of cover are ultimately met.

B. Field observations and data collected on sites within the Mount Haggin IA indicate that selected sites are generally low in total vegetative cover and diversity of native species and are thus appropriate for Restoration Enhancement Planting (**Specification 6.7**). The specification for Replacement Plant Installation is a companion specification to

Restoration Enhancement Planting. Specifically, Restoration Enhancement Plantings and the potential requirement for Replacement Plant Installation will address the overall lack of vegetative cover and low native species richness on the sites to be restored. Refer to **Section 4** for a full discussion of these field observations and collected data.

C. Replacement Plant Installation is specified for all treatment sites of the IA that will be receiving Restoration Enhancement Planting (**Specification 6.7**). Restoration Enhancement Plantings are specified under the Active Restoration Alternative, for all treatment areas of the IA, including BA, SDG, DG, SSR and IG.

6.12.1.3 Coordination With Remedy.

A. Replacement Plant Installation is a companion specification to Restoration Enhancement Planting (**Specification 6.7**) and as such, is specified under the Active Restoration Alternative for BA, SDG, and DG, for which there is currently no proposed remedial action. This treatment is also specified under the Active Restoration Alternative for SSR and IG. Thus, this treatment represents an additional work item for SSR and IG sites.

B. Replacement Plant Installation is specified to occur during the Spring of Years Four through Seven on BA, SG, SDG, and IG sites and during the Spring of Years Ten through Thirteen on SSR sites.

6.12.2 Products and Materials

6.12.2.1 Containerized Plant Materials.

A. The containerized plant materials specified for use with this treatment shall be 10 cubic inch seedlings or the equivalent size, propagated in a rigid container such as a "Super-Cell" as manufactured by Steuwe & Sons or Corvallis, OR, or the equivalent. Seedlings shall be propagated from an appropriate local or regional seed source. Selected species shall include dominant species representative of mid-successional phases of the individual native habitat types to be restored **(Table 6-2)**. Seedlings shall be hardened-off to ambient temperatures and sun exposure for a minimum of two weeks prior to planting.

B. The total quantity and density of replacement plantings shall be based upon the results of Restoration Monitoring (**Specification 6.14**). Replacement species shall be representative of the habitat types to be restored. Cost estimates are based on a 20% replacement of the plant quantities originally planted (**Specification 6.7.2.1**).

6.13 Noxious Weed Control- (all sites)

6.13.1 Scope Of Work

6.13.1.1 Definition. Noxious weed control refers to actions that will eliminate or reduce the influence of observed noxious weed species. Biocontrol is identified as the technique of choice for control of noxious weeds. Biocontrol is a term used to describe the use of insects or pathogens that consume the roots, stems, foliage and flower heads of the target plants as a means of controlling their populations. Several biocontrol insects and pathogens have been proven effective in Montana and are described in detail by the Montana Weed Control Association (MWCA 2001). This Plan recognizes that effective control agents are not available for all noxious weeds and that spot application of herbicides may be a necessary addition to this treatment. Insects or pathogens specific to the target noxious weed can be purchased from biocontrol vendors. The biocontrol agents are released in established patches of noxious weeds and allowed to multiply and consume noxious weed resources. Established populations of biocontrol insects can be harvested and moved to other noxious weed infestations.

6.13.1.2 Technical Feasibility.

A. Biocontrol is specified in order to address the need to control noxious weed species present in the Mount Haggin IA.

B. Field observations and data collected on sites within the IA indicate the presence of the following state-listed noxious weed species: leafy spurge, spotted knapweed, and Canada thistle. Refer to **Section 4** for a full discussion of these field observations and collected data.

C. All sites containing state-listed noxious weeds will be treated with biocontrol.

6.13.1.3 Coordination With Remedy.

A. Noxious Weed Control is specified for BA, SDG, and DG, for which there is currently no proposed remedial action. For remedy sites designated as SSR and IG, the use of biocontrol as a method to control the presence of noxious weeds is not addressed in the proposed remedial action. Thus, this treatment represents an additional work item for SSR and IG sites.

B. Noxious Weed Control is specified to occur during the Fall of Years Three through Seven on BA, SG, SDG, and IG sites and during the Fall of Years Nine through Thirteen on SSR sites.

6.13.2 Products and Materials

6.13.2.1 Spurge flea beetle (*Aphthona spp.*) combination.

A. Three species of spurge flea beetle will be used in combination to control leafy spurge. These species are as follows: black dot spurge flea beetle (*Aphthona nigriscutis*), amber spurge flea beetle (*A. flava*), and brown-legged spurge flea beetle (*A. lacertosa*). In general, spurge flea beetle adults feed extensively on the leaves and bracts of leafy spurge. Females lay an average of 225 eggs at the base of leafy spurge plants. Developing larvae feed upon primary and secondary roots and cause considerable damage to infested plants.

B. Five pre-packaged cartons containing approximately 1,000 spurge flea beetles each will be released per acre of leafy spurge infestation. Cost estimates are based upon a unit price of $110/ carton of spurge flea beetles.

6.13.2.2 Spurge shoot-tip gall midge (*Spurgia esulae*).

A. Females within this species lay eggs upon the tips of aboveground stems of leafy spurge. Developing larvae then begin feeding upon the tips of stems causing the affected plant to form galls surrounding the larvae. Gall formation effectively prevents flowering and seed production on the attacked stem, and reduces carbohydrate reserves.

B. Two pre-packaged cartons containing approximately 500 adults each will be released per acre of leafy spurge infestation. Cost estimates are based upon a unit price of $55/ carton of spurge shoot-tip gall midges.

6.13.2.3 Knapweed root weevil (*Cyphocleonus achates*).

A. Females within this species lay approximately 100 eggs at the base of older knapweed plants. Developing larvae feed on the plant's central taproot, thus damaging vascular tissue and causing the formation of root galls.

B. Two pre-packaged cartons containing approximately 100 adults each will be released per acre of knapweed infestation. Cost estimates are based upon a unit price of $165/ carton of knapweed root weevils.

6.13.2.4 Knapweed flowerhead weevils (*Larinus spp.*).

A. Two species of knapweed flowerhead weevils will be used in combination to control knapweed. The two species are as follows: blunt knapweed flowerhead weevil (*Larinus obtusus*) and lesser flowerhead weevil (*L. minutus*). Females within both of these species lay eggs within the flowers of knapweed plants. Developing larvae feed upon the flower heads and greatly diminish the number of seeds produced.

B. Two pre-packaged cartons (one carton for each species) containing approximately 100 adults each will be released per acre of knapweed infestation. Cost estimates are based upon a unit price of $110/ carton of knapweed flowerhead weevils.

6.13.2.5 Thistle stem gall fly (*Urophora cardui*).

A. Females within this species lay eggs at the base of Canada thistle plants in early summer when plants are in the bolting phase. Developing larvae feed on shoot tissue causing the affected plant to form hard, woody stem galls surrounding the larvae. Gall formation disrupts the movement of water and nutrients within the affected stem that leads to reduced vigor and seed production.

B. Four pre-packaged cartons containing approximately 100 adults each will be released per acre of Canada thistle infestation.

6.13.2.6 Canada thistle flower weevil (*Larinus planus*).

A. Females within this species lay eggs in flower heads of Canada thistle plants. Developing larvae feed in the flower heads, thereby decreasing seed production. Additionally, adults within this species feed on the foliage of Canada thistle plants causing an overall decline in plant vigor.

B. Four pre-packaged cartons containing approximately 100 adults each will be released per acre of Canada thistle infestation.

6.13.2.7 Canada thistle stem weevil (*Ceutorhynchus litura*).

A. Females within this species deposit eggs in young shoots of Canada thistle during spring. The developing larvae then feed on, or "mine," the inside of elongating stems during the growing season. Fully developed larvae then exit the plant near the root crown, leaving multiple exit holes and further damaging the stem tissue.

B. Four pre-packaged cartons containing approximately 100 adults each will be released per acre of Canada thistle infestation.

6.13.2.8 Thistle defoliating beetle (*Cassida rubiginosa*).

A. Both adults and developing larvae of this species feed extensively on Canada thistle leaf tissue throughout the spring, summer, and fall causing an overall decline in plant vigor.

B. Four pre-packaged cartons containing approximately 100 adults each will be released per acre of Canada thistle infestation.

6.14 Restoration Monitoring- (all sites)

6.14.1 Scope Of Work

6.14.1.1 Definition. Restoration Monitoring refers to actions that will guide site management decisions and determine the effectiveness of restoration efforts. Restoration monitoring activities will include plant surveys and survival counts. Plant surveys will consist of traversing established routes across restoration treatment areas and recording the presence or absence of plant species. Plant surveys will identify weed control needs and document the development of species richness. Survival counts will occur on transects established at the time of outplanting activities. The presence and growth status of plants will be recorded and survival rates calculated in order to guide replanting efforts.

6.14.1.2 Technical Feasibility.

A. Restoration Monitoring is specified in order to guide future management of the restored area and to assess the success or failure of the project.

B. The restoration treatments require quantitative feedback in order to determine replanting, plant maintenance, and biocontrol needs. Restoration Monitoring will provide the required feedback. Also, qualitative feedback is required to determine whether the anticipated ecological responses and criteria for effectiveness identified within the proposed alternatives are being met.

C. A representative sample of the restoration units will be sampled and surveyed.

6.14.1.3 Coordination With Remedy.

A. Restoration Monitoring is specified for BA, SDG, DG, SSR and IG sites.

B. Restoration monitoring is specified to occur during the Summer of Years Three through Seven on BA, SG, SDG, and IG sites and during the Summer of Years Nine through Thirteen on SSR sites.

6.14.2 Products and Materials

6.14.2.1 Restoration Monitoring.

A. No materials are required.

B. Costs for Restoration Monitoring are based upon an estimate of 1% of the total cost for site restoration activities.

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Section 7: Descriptions of Restoration Species

The following section outlines key attributes of plants targeted for use in restoration efforts at the Mount Haggin IA. The majority of information in this section was compiled directly from the USDA Forest Service Rocky Mountain Research Station's Fire Sciences Laboratory in Missoula, Montana. When information on a particular species was unavailable, other sources are noted.

7.1 Rocky Mountain Douglas-fir (*Pseudotsuga menziesii* var. *glauca*)

Habit. Coniferous, evergreen tree seldom exceeding 130 feet in height and 5 feet in diameter.

Associated Species. Englemann spruce, subalpine fir, limber pine, lodgepole pine, Rocky Mountain juniper, spirea, Oregon grape, common juniper, chokecherry, serviceberry, dwarf huckleberry, pinegrass, elk sedge, bluebunch wheatgrass, Idaho fescue, arrowleaf balsamroot, heart-leaved arnica.

Habitat Value. Douglas-fir habitat types provide excellent hiding and thermal cover for big game species. Mule deer, elk, and moose may browse foliage to varying degrees in the winter or early spring when other preferred forage is lacking. Small mammals such as chipmunks, mice, voles, and shrews eat large quantities of conifer (including Douglas-fir) seeds from the forest floor, and red squirrels cut great quantities of Douglas-fir cones and cache them for later use. Numerous species of songbirds extract seeds from Douglas-fir cones and forage for seeds on the ground. Douglas-fir snags are important for cavity-nesting birds. Needles are an important winter food of blue grouse.

Restoration and Erosion Control Considerations. Douglas-fir exhibits considerable genetic variation, and seed for restoration purposes should come from nearby seed sources. Seedlings will establish and grow over a wide range of aspects, slopes, landforms, and soils. Seedlings generally establish best on mineral soils or organic seedbeds of less than 2 inches and under partial shade. This species is occasionally planted for erosion control. Its erosion control potential is rated as medium in Utah, and high in Colorado and Wyoming.

Management Implication. Western spruce budworm, Douglas-fir tussock moth, and Douglas-fir beetle are the most common insect pests. Dwarf mistletoe is a serious problem in dry Douglas-fir forests. Mean fire interval for Douglas-fir forests in southwestern Montana is 40 to 45 years. Low growing branches and flammable foliage can carry ground fires into the crown.

Source: FEIS (Uchytil, Ronald J. and M. Crane. 1991)

7.2 Engelmann Spruce (*Picea engelmannii*)

Habit. Coniferous, evergreen tree reaching 160 feet in height and 40 inches in diameter in favorable sites. Height is much reduced near tree line, often forming krummholz.

Associated Species. Subalpine fir, lodgepole pine, Douglas-fir, grouse whortleberry, globe huckleberry, pinegrass, elk sedge, mountain arnica, beargrass

Habitat Value. Englemann spruce dominated forests provide excellent hiding and thermal cover for big game species. Ungulates may browse young growth when other preferred forage is lacking. Small mammals such as chipmunks, mice, and voles eat large quantities of conifer (including Englemann spruce) seeds from the forest floor, and squirrels sometimes clip and eat spruce twigs and buds. Numerous species of songbirds feed on spruce seed. Snags, particularly those over 11 inches in diameter, are important for cavity-nesting birds. Blue grouse and spruce grouse may feed extensively on buds and needles.

Restoration and Erosion Control Value. A valuable restoration species for cool, moist sites at higher elevations near tree line. Has been used successfully for long-term stabilization of high elevation mine spoils. Planting of nursery grown seedlings more successful than direct seeding, but young seedlings need protection from direct sun. Seedlings establish best on mineral soils, but a shallow duff layer may be beneficial at higher elevations to protect against high intensity rain storms and frost heaving. A very slow growing species; however, 2 to 4 foot tall open grown trees have been successfully transplanted. Species grows best in moderately deep, well-drained loamy soils derived from volcanic, sedimentary, or alluvial materials.

Management Implications. Wood-rotting fungi may attack roots and lower trunk near soil level. Spruce beetle is the most common insect pest; thrives in areas where large amounts of downed woody debris exist (due to windthrow, slash, etc.). Mean fire interval is approximately 150 years.

Source: FEIS (Uchytil, Ronald J. 1990)

7.3 Limber Pine (*Pinus flexilis*)

Habit. Slow-growing, long-lived evergreen coniferous tree rarely exceeding 50 feet in height and 6.5 feet in diameter. Grows between 4,000 to 6,000 feet elevation in Montana.

Associated species. Lodgepole pine, Douglas-fir, Rocky Mountain juniper, big sagebrush, russet buffaloberry, bitterbrush, sprirea, Oregon grape, common juniper, snowberry, chokecherry, serviceberry, bluebunch wheatgrass, arrowleaf balsamroot.

Habitat Value. Seeds or "nuts" of this species are large, highly nutritious, and provide critical food for numerous bird (especially Clark's nutcracker) and rodent species which cache seeds for later use. Other birds, small mammals, and even bears utilize these caches. Sites with limber pine provide key winter range for deer and elk, and bighorn sheep use open stands on ridges.

Restoration and Erosion Control Value. Because of its slow growth rate, this species has not been used extensively in restoration. It has been used with success for revegetation of high elevation mining disturbances in Colorado; inoculation of seedlings with ectomycorrhizae and incorporation of organic amendments in planting medium improved growth and survivability in one study. A drought-tolerant species adapted to steep, rocky, well-drained, and nutrient-poor soils. Litter accumulation and ground cover are often sparse in limber pine dominated sites; severe sheet erosion of fine soil particles is possible during high-intensity summer rain storms.

Management Implications. Highly susceptible to white pine blister rust. Can be heavily colonized and killed by dwarf mistletoe. Susceptible to invasion by mountain pine beetles, cone beetles, coneworms, and budworms. Older trees are tolerant of low intensity ground fires; mean fire interval is highly variable and depends on associated species with which it grows.

Source: FEIS (Johnson, Kathleen A. 2001)

7.4 Lodgepole Pine (*Pinus contorta*)

Habit. Short-lived, evergreen, coniferous tree ranging in height from 50 to 100 feet, and having diameters of 7 to 13 inches. Grows between 4,000 to 7,500 feet elevation in Montana.

Associated species. Subalpine fir, Engelmann spruce, Douglas-fir, grouse whortleberry, globe huckleberry, sprirea, Oregon grape, common juniper, snowberry, chokecherry, serviceberry, pinegrass, elk sedge, bluebunch wheatgrass, Idaho fescue, beargrass.

Habitat Value. Provides good thermal and hiding cover for deer, elk, moose, and bear. Ungulates may browse foliage, but only when more palatable forage is lacking. Seeds are an important food of pine squirrels; chipmunks and numerous songbirds also consume the seeds. Needles serve as an important winter food source for blue grouse and spruce grouse.

Restoration and Erosion Control Value. Because this species can tolerate a broad range of temperature and moisture regimes, it is used extensively in reclamation and reforestation projects in montane and subalpine ecosystems. Trees can be established either by direct seeding or planting of container grown plants. Seedlings establish best on mineral soils of a medium texture, but are weak competitors and establishment is reduced in the presence of grasses. To avoid "dog-hair" stands, stocking rates should not exceed 500 to 800 stems per acre 5 to 20 years following planting.

Management Implications. Natural regeneration by seed occurs following high intensity crown fires which releases seed from serotinous cones; low intensity ground fires do not generate enough heat to release seed. The interval between stand replacing fires in lodgepole pine forests in the northern Rockies varies widely (from 75 to 300 years) and depends on litter accumulation, insect/disease outbreaks, and mean annual precipitation. Mountain pine beetle is the most serious insect pest, and dwarf mistletoe can be problematic.

Source: FEIS (Uchytil, Ronald J. 1992)

7.5 Rocky Mountain Juniper (*Juniperus scopulorum*)

Habit. Slow-growing, long-lived, evergreen, coniferous, erect shrub or small tree that grows up to 20 to 50 feet in height and 15 inches in diameter. Grows between 5,500 to 6,500 feet elevation in Montana.

Associated species. Douglas-fir, limber pine, lodgepole pine, big sagebrush, russet buffaloberry, bitterbrush, sprirea, Oregon grape, common juniper, snowberry, chokecherry, serviceberry, bluebunch wheatgrass, Idaho fescue, arrowleaf balsamroot.

Habitat Value. Provides thermal and hiding cover for deer, elk, bighorn sheep, and antelope; also provides limited browse for these species when more palatable forage is lacking. The "berries" are readily consumed by migratory birds, turkeys and other game birds, and small mammals.

Restoration and Erosion Control Value. A drought-tolerant species adapted to steep, rocky, well-drained, and nutrient-poor soils. Litter accumulation and ground cover are often sparse in limber pine dominated sites; severe sheet erosion of fine soil particles is possible during high-intensity summer rain storms.

Management Implications. Highly susceptible to white pine blister rust. Can be heavily colonized and killed by dwarf mistletoe. Susceptible to invasion by mountain pine beetles, cone beetles, coneworms, and budworms. Older trees are tolerant of low intensity ground fires; mean fire interval is highly variable and depends on associated species with which it grows.

Source: FEIS (Johnson, Kathleen A. 2001)

7.6 Antelope Bitterbrush (*Purshia tridentata*)

Habit. Long-lived, multistemmed, decumbent, evergreen shrub that may reach 12 to 15 feet, but more commonly grows to 3 to 4 feet in height. Typically found between 5,500 to 6,500 feet in elevation in southwestern Montana.

Associated species. Douglas-fir, Rocky Mountain juniper, limber pine, lodgepole pine, big sagebrush, russet buffaloberry, sprirea, Oregon grape, common juniper, snowberry, chokecherry, serviceberry, bluebunch wheatgrass, arrowleaf balsamroot.

Habitat Value. Used extensively as browse by pronghorn antelope, elk, bighorn sheep, and moose in all seasons; may serve as critical browse in winter for mule deer. Seed is a large part of the diet of several rodent species, and rodents may cache large amounts of seed in a given year. May serve as important cover for sage grouse and Lewis' woodpeckers.

Restoration and Erosion Control Value. Has been used successfully in mineland reclamation projects, including reclamation of acidic mine wastes. Some ecotypes have nitrogen fixing root nodules as a result of a symbiotic association with *Frankia spp.* actinomycetes. Degree of nodulation depends on site conditions, such as soil moisture content and salinity, and available nitrogen. Establishment of seedlings via broadcast or drill seeding is generally poor, whereas planting of container-grown stock typically ensures greater seedling establishment. Species exhibits considerable genetic variation, and seed for restoration purposes should come from nearby seed sources. Tolerates a wide variety of soils, with coarse textured soils generally best; does not, however, tolerate saline soils.

Management Implications. Species is moderately to highly browse tolerant. Browsing by ungulates may help to maintain stands in a seral stage and increase shrub vigor. Young seedlings do not compete well with weedy species, especially cheatgrass. Highly susceptible to fire kill, but some ecotypes sprout after fire.

Source: FEIS (Zlatnik, Elena. 1999)

7.7 Common Chokecherry (*Prunus virginiana*)

Habit. Deciduous, thicket-forming erect shrub or small tree ranging in height from 5 to 30 feet. Typically grows between 5,500 and 7,000 feet in elevation in southwestern Montana.

Associated species. Douglas-fir, Rocky Mountain juniper, limber pine, lodgepole pine, big sagebrush, bitterbrush, russet buffaloberry, sprirea, Oregon grape, common juniper, snowberry, serviceberry, bluebunch wheatgrass, arrowleaf balsamroot.

Habitat Value. Large mammals including bear, moose, coyote, bighorn sheep, pronghorn antelope, deer and elk utilize this species for browse and cover throughout the year. Small mammals and, especially, bird species feed heavily on ripened fruits and utilized plants for cover. Excellent shrub species for providing thermal cover and erosion control in fisheries.

Restoration and Erosion Control Value. Has been used for wildlife enhancement, mineland reclamation, and soil stabilization. Container-grown seedlings can be propagated from seed or rhizome cuttings, and establish well if competition from grasses, forbs, and/or weedy species is reduced near the plant. Grows in a wide variety of soil types and can tolerate weakly saline soils; however, is intolerant of poor drainage and prolonged flooding.

Management Implications. Species is moderately browse tolerant, but heavy browsing may negatively impact populations. Resprouts rapidly and prolifically following fire.

Source: FEIS (Johnson, Kathleen A. 2000)

7.8 Common Juniper (*Juniperus communis*)

Habit. Coniferous, evergreen, often mat-forming shrub growing up to 5 feet in height. Typically found between 5,500 to 7,000 feet in elevation in southwestern Montana.

Associated species. Douglas-fir, Rocky Mountain juniper, limber pine, lodgepole pine, big sagebrush, russet buffaloberry, sprirea, Oregon grape, common juniper, snowberry, chokecherry, serviceberry, globe huckleberry, grouse whortleberry, bluebunch wheatgrass, arrowleaf balsamroot.

Habitat Value. Ungulates may browse sparingly during the late winter or early spring if other more palatable forage is unavailable. Serves as cover for small mammals and bird species. Birds, especially American robin and black-capped chickadee, feed on cones whenever available.

Restoration and Erosion Control Value. Because of low, mat-forming habit, this species is moderately to highly useful for erosion control once established. Planting of container grown or bare root seedlings are the most practical method for reestablishing plants. Germination and establishment of seedlings, however, is rated as difficult. Difficulty of seed germination is partly due to a thick seedcoat, a dormant embryo, and low viability of seed from older plants. The passing of seed through the digestive system of animals may enhance germination. Stem cuttings have the ability to root and may serve as another option for propagation.

Management Implications. This species may increase in density and cover in the presence of moderate to heavy grazing. Often reaches its maximum abundance on harsh, open sites. Foliage is resinous and highly flammable and plants do not resprout following fire.

Source: FEIS (Tirmenstein, D. 1999)

7.9 Oregon Grape (*Berberis repens*)

Habit. Evergreen, perennial, rhizomatous shrub with a low or prostrate growth form. Typically found between 5,500 to 7,000 feet in elevation in southwestern Montana.

Associated species. Douglas-fir, Rocky Mountain juniper, limber pine, lodgepole pine, big sagebrush, russet buffaloberry, sprirea, Oregon grape, common juniper, snowberry, chokecherry, serviceberry, bluebunch wheatgrass, arrowleaf balsamroot.

Habitat Value. Fruits are eaten by a number of bird and mammal species, including black bears. Ungulates rarely browse this plant, but mule deer in Montana readily utilize browse in the fall and winter months.

Restoration and Erosion Control Value. Because it is an evergreen, rhizomatous ground cover that is both heat and drought tolerant, this plant has been suggested for use in the revegetation of rangelands, mines, roadsides, and recreational areas. Container grown plants can be propagated by seeds, suckers, cuttings, and layering. Can also be direct seeded; seeds need no pretreatment if seeded in the fall, but require cold stratification if sown in the spring. Grows best on sandy loams to silts, and in western Montana is often found on limestone soils and rarely occurs on granitic or quartzite soils.

Management Implications. Serves as an alternate host for black stem rust, a serious pathogen of cereal crops. Grows well in both shaded and open environments, and is one of the most resistant evergreen shrub species to winter sun scald. Top growth is killed during fire, but plants resprout from dormant buds on rhizomes.

Source: FEIS (Walkup, Crystal J. 1991)

7.10 Russet Buffaloberry (*Shepherdia canadensis*)

Habit. Deciduous, nitrogen-fixing shrub ranging in height from 3 to 13 feet. Typically found between 5,500 to 6,500 feet in elevation in southwestern Montana.

Associated species. Douglas-fir, Rocky Mountain juniper, limber pine, lodgepole pine, big sagebrush, russet buffaloberry, sprirea, Oregon grape, common juniper, snowberry, chokecherry, serviceberry, bluebunch wheatgrass, arrowleaf balsamroot.

Habitat Value. Provides low to moderate amounts of browse for ungulates and small mammals. Berries, which ripen mid- to late-summer, are used extensively by numerous wildlife species, especially black bear, grizzly bear, and grouse. Provides good cover for bird species, but only poor to fair cover for ungulates and small mammals.

Restoration and Erosion Control Value. Because of its nitrogen-fixing ability (due to a symbiotic association with *Frankia spp.* actinomycetes), it is useful for the revegetation of disturbed land. Has been used successfully for mineland reclamation in Idaho. Planting of container-grown stock is the best method of reestablishing this species. Germination from seed is often low, highly erratic, or delayed (stratification and/or scarification treatments may improve germination). Vegetative propagation of this species is possible from root cuttings. Generally most abundant of sandy, gravelly, or rocky soils, and often thrives on nutrient-poor soils.

Management Implications. Top growth is killed during fires, but plants will resprout from the root crown or dormant buds on roots. This species is not an aggressive resprouter, however, and may take longer than other resprouting shrubs to regenerate following fire.

Source: FEIS (Walkup, Crystal J. 1991)

7.11 Serviceberry (*Amelanchier alnifolia*)

Habit. Deciduous shrub or small tree reaching 3 to 25 feet in height, and often forming thickets. Typically found between 5,500 to 7,000 feet in elevation in southwestern Montana.

Associated species. Douglas-fir, Rocky Mountain juniper, limber pine, lodgepole pine, big sagebrush, russet buffaloberry, sprirea, Oregon grape, common juniper, snowberry, chokecherry, bluebunch wheatgrass, arrowleaf balsamroot.

Habitat Value. Twigs and foliage serve as valuable browse for ungulates primarily in the winter and spring. Although highly palatable, large amounts of or a diet consisting heavily or solely on this species can be fatal to mule deer. Grouse and other upland game bird species consume the fruits and buds, and several species of songbirds and rodents eat the fruits.

Restoration and Erosion Control Value. This species has been used for mineland reclamation and for wildlife and watershed enhancement projects. Container grown plants can be established for either seed or vegetative cuttings. Established plants have a large rootcrown, horizontal and vertical rhizomes, and an overall extensive root system. Grows in a broad range of habitat and soil types, but is generally not tolerant of prolonged drought.

Management Implications. Good seed crops may only be produced in 3 out of every 5 years, on average, due to drought, spring frost, or juniper rust. Intolerant of deep shade and declines quickly with canopy closure. Fire kills top growth, but the presence of both shallow and deeply buried rhizomes allows plants to resprout after light to high intensity fires.

Source: FEIS (Hickerson, Jody. 1986)

7.12 Snowberry (*Symphoricarpos albus*)

Habit. Deciduous , densely branched, rhizomatous shrub ranging from 3 to 5 feet in height. Typically found between 5,500 to 7,000 feet in elevation in southwestern Montana.

Associated species. Douglas-fir, Rocky Mountain juniper, limber pine, lodgepole pine, big sagebrush, russet buffaloberry, sprirea, Oregon grape, common juniper, chokecherry, serviceberry, dwarf huckleberry, bluebunch wheatgrass, arrowleaf balsamroot.

Habitat Value. Reports in the literature vary, but this species is generally an important source of browse and food for ungulates and large mammals, such as grizzly bear. Serves as cover and food for several bird species (namely grouse, kingbird, and western flycatcher) and rodent species.

Restoration and Erosion Control Value. Widely used in the restoration of disturbed sites, including mining disturbances and degraded stream banks. Because of its rhizomatous growth habit, it possesses excellent bank stability and erosion control properties. Container grown plants can be started from seed or vegetative cuttings. Seedling establishment in the field is rated as fair, but once established, survival is high. Occurs on a wide variety of soils, is tolerant of mildly acidic to moderately alkaline conditions, and is somewhat tolerant of saline conditions. Often grows best on well-drained soils of limestone origin.

Management Implications. Often forms low growing thickets which can provide shade for the germination and establishment of other species, especially conifers. Top growth is killed by fires, but quickly resprouts from rhizomes.

Source: FEIS (McWilliams, Jack. 2000)

7.13 **Spirea (*Spirea betulifolia*)**

Habit. Deciduous, rhizomatous shrub ranging from 1 to 3 feet in height. Typically found between 5,500 to 7,000 feet in elevation in southwestern Montana.

Associated species. Douglas-fir, Rocky Mountain juniper, limber pine, lodgepole pine, big sagebrush, russet buffaloberry, sprirea, Oregon grape, common juniper, chokecherry, serviceberry, globe huckleberry, grouse whortleberry, bluebunch wheatgrass, arrowleaf balsamroot.

Habitat Value. Overall, this species provides poor forage and cover resources for all classes of wildlife.

Restoration and Erosion Control Value. This species has not been used extensively for restoration purposes. Container grown plants can be started either from seed or vegetative cuttings, but are slow to establish in the field, often requiring 3 years to fully establish. This species, however, has been rated as medium for soil erosion reduction potential in southwestern Montana due to its moderately aggressive growth, once established. Often found on dry, rocky sites, but will also grow well in more moist sites near riparian areas or at higher elevations.

Management Implications. Because it is not a preferred forage species, spirea may be a good choice for the restoration of disturbed sites in drier montane forests. It is not a shade tolerant species, and will give way to other more shade tolerant species following forest canopy closure. Often regenerates quickly following disturbances such as fire.

Source: FEIS (Habeck, R. J. 1991)

7.14 Wood's Rose (*Rosa woodsii*)

Habit. Fast-growing, rhizomatous shrub ranging in height from 1.5 to 6 feet. Typically does not grow above 6,500 feet elevation in Montana.

Associated species. Snowberry, chokecherry, hawthorn, serviceberry, big sagebrush, willow, quaking aspen, beardless wildrye.

Habitat Value. Browsed by ungulates from spring through fall, with most use occurring in early spring when new leaves emerge. Fruits, or "rose hips," persist on the plant through much of the winter and are readily eaten by numerous bird species, wintering mule deer, and squirrels. Coyote and bear have also been reported to feed on the fruit. Thickets of this species along riparian corridors provide fair to good cover for many bird and small mammal species.

Restoration and Erosion Control Value. Used extensively for erosion control and wildlife habitat enhancement in mineland, roadcut, and riparian restoration projects. Plants can be established in the field through installation of container grown stock or hardwood cuttings, and by direct seeding. Typically found in riparian corridors, on dry grassy slopes, and in disturbed areas (such as road cuts and cut slopes) throughout the Rockies. Grows on a wide variety of soils, but typically prefers moist, well-drained soils associated with riparian areas. Will also tolerate moderately acidic to mildly basic soils.

Management Implications. Has a fairly high tolerance to browsing. Can be potentially affected by a number of insect and disease pests. Top growth is killed by fire, but can resprout from buried rhizomes following low to moderate severity fires.

Source: FEIS (Tesky, Julie L. 1992)

7.15 Great Basin Wildrye (*Leymus cinereus*)

Habit. Robust, cool-season, perennial bunchgrass that ranges in height from 3 to 6 feet. Typically found between 3,200 and 6,700 feet in Montana.

Associated species. Big sagebrush.

Habitat Value. Forage is very coarse after maturity and is generally considered inferior. Provides elk, however, with spring, fall, and winter forage. Stands can provide cover and bedding areas for deer, birds, and small mammals. Bird and rodent species also utilize the seeds for food.

Restoration and Erosion Control Value. Not used extensively in the past due to poor germination and seedling vigor. Improved cultivars have been developed ('Magnar' and 'Trailhead') which overcome these problems. The use of these cultivars for the revegetation of disturbed sites with saline and/or alkaline soils is recommended. This species is also recommended for riparian restoration in mountain-brush and mountain big sagebrush communities where annual precipitation is greater than 10 inches. When using seed from improved cultivars in seed mixtures, the seeding rate of this species should be lowered as seedlings can be quite competitive and may suppress other species. This species exhibits a great deal of genetic variation among populations; the use of a local seed source or seed from improved cultivars adapted to local conditions is highly recommended. If the use of local seed is preferred over seed from cultivars, outplanting with container grown seedlings (as opposed to direct seeding with local seed) is a viable option.

Management Implications. Susceptible to damage from spring grazing or frequent cutting during the growing season. Research has indicated that spring grazing should be withheld until new growth reaches at least 10 inches and remaining stubble should not be less than 6 inches. Generally survives fire to become part of the early seral post-fire community.

Source: FEIS (McMurray, N. 1987)

7.16 Bluebunch Wheatgrass (*Pseudoroegneria spicata*)

Habit. Drought-resistant, perennial, cool-season grass with densely tufted culms that reaches 12 to 30 inches in height. Typically found between 5,000 and 7,500 feet in Montana.

Associated species. Douglas-fir, englemann spruce, limber pine, lodgepole pine, Rocky Mountain juniper, spirea, Oregon grape, common juniper, chokecherry, serviceberry, Idaho fescue, rough fescue, arrowleaf balsamroot.

Habitat Value. Considered one of the most important forage species for wildlife on western rangelands. Elk, mule deer, bison, and bighorn sheep, in particular, make high use of this species during the winter months. Rough fescue/bluebunch wheatgrass habitat types may provide suitable cover for ground-nesting birds.

Restoration and Erosion Control Value. Used extensively for the restoration of mine- and rangelands. Reports in the literature vary, but may be difficult to establish from seed and have low seedling vigor. Once established, however, plants develop an extensive root system, are extremely drought tolerant, and are an excellent choice for soil stablilization. Improved cultivars for this species and beardless bluebunch wheatgrass (*P. spicata* ssp. *inermis*) have been developed that have high germination rates and seedling vigor. This species requires well-drained soils and will not tolerate excessively saline soil conditions.

Management Implications. Plants are extremely sensitive to defoliation during active growth, but are moderately grazing tolerant during the non-growing period. Does not compete will with introduced and/or weedy species such as spotted knapweed, cheatgrass, and crested wheatgrass. Plants generally tolerate fire and will resprout following fire. Mean fire intervals for bluebunch wheatgrass habitat types are highly variable, but are generally under 30 years.

Source: FEIS (Zlatnik, Elena. 1999)

7.17 Bottlebrush Squirreltail (*Sitanion hystrix*)

Habit. Drought-resistant, perennial, cool-season grass 12 to 18 inches in height. Typically found throughout a broad elevation range in Montana.

Associated species. No information.

Habitat Value. Overall, use of this species by wildlife is generally low, but forage may be utilized by ungulates and small mammals mostly during winter and spring months.

Restoration and Erosion Control Value. Widely used for restoration throughout the West due to its ability to colonize disturbed sites. In particular, this species is recommended for use in the restoration of pinyon-juniper, sagebrush, and lodgepole pine communities. Bottlebrush squirreltail inhabits a wide variety of soil types, and, throughout Montana, it occurs predominantly on dry, gravelly soils, in saline or alkaline areas. This species competes well with, and can invade areas dominated by, such weedy species as cheatgrass, medusahead, and Japanese brome. A great deal of ecotypic or genetic variation exists within this species; seed used for restoration projects should come from local seed sources or from appropriate improved cultivars.

Management Implications. Tolerant of light to moderate grazing, but long, sharp awns develop on infloresences in late spring through summer that may cause injury to the eyes, nostrils, and mouths of grazing animals. Also tolerant of fire, and is found in the early seral, post-fire plant communities of numerous habitat types, either establishing from on- or off-site seed, or resprouting from existing rootcrowns.

Source: FEIS (Simonin, Kevin A. 2001)

7.18 Sandberg Bluegrass (*Poa secunda*)

Habit. Shallow-rooted, short-lived, cool-season, perennial bunchgrass 6 to 18 inches in height. Typically found throughout a broad elevation range in Montana.

Associated species. No information.

Habitat Value. One of the first grass species to green up in the early spring, but usually goes dormant by early summer. Provides fair to good forage for elk and mule deer in Montana. Small mammal species, such as ground squirrels, may utilize forage, as well.

Restoration and Erosion Control Value. Used extensively throughout the West, especially for mineland reclamation. This species occurs on flats and ridgetops, slopes, meadows, and open timberline. It grows well in rich clay loam soils, but most often inhabits shallow, rocky, or sandy soils. This species is very drought tolerant.

Management Implications. Tolerant of moderate to heavy grazing, but stands generally produce low amounts of forage, compared to other grass species. Although drought tolerant, this species produces very little forage in drought years, and is not a dependable forage species during dry years. This species is generally unharmed by fire because it produces little litter, and its small bunch size and sparse litter reduces the amount of heat transferred to perennating buds in the soil. Its rapid maturation in the spring also reduces fire damage, since it is dormant when most fires occur. Cover often increases when interference from other species is reduced by fire.
Source: FEIS (Bradley, Anne. 1986; Howard, Janet L. 1997)

7.19 Idaho Fescue (*Festuca idahoensis*)

Habit. Long-lived, cool season, perennial bunchgrass that forms dense clumps and grows from 1 to 3 feet in height. Typically found from 5,000 to 7,500 feet in southwestern Montana

Associated species. Douglas-fir, englemann spruce, limber pine, lodgepole pine, Rocky Mountain juniper, spirea, Oregon grape, common juniper, chokecherry, serviceberry, bluebunch wheatgrass, rough fescue, prairie junegrass, western needlegrass, arrowleaf balsamroot, yarrow.

Habitat Value. The Idaho fescue/bluebunch wheatgrass habitat type in southwestern Montana is widely used by big game animals. Elk and deer use the type as low-elevation winter range, and pronghorn use it year-round. At intermediate elevations Idaho fescue is important spring-fall range, and at upper elevations it provides summer range for elk and mule deer. This species may be included in the diets of northern pocket gophers and grizzly bears, and is a common understory component of grouse habitat in Montana.

Restoration and Erosion Control Value. Idaho fescue is slow to establish, but once established, has abundant growth of fine leaves that provide effective ground cover, and high yields of tough, fine, fibrous roots that control erosion and improve soil structure. It grows on a wide variety of soils types, but generally has a poor tolerance to salinity. The presence of competitive non-native species such as cheatgrass and spotted knapweed may inhibit the growth and establishment of this species, but once Idaho fescue is established, it can resist the invasion of non-native species. A great deal of ecotypic or genetic variation exists within this species; seed used for restoration projects should come from local seed sources or from appropriate improved cultivars.

Management Implications. This species is generally favored by light to moderate grazing, but often decreases in cover and abundance under heavy grazing. Plants are not harmed by light severity fires, and typically reestablish through rapid tillering or from seed.

Source: FEIS (Zouhar, Kristin L. 2000).

7.20 Rough Fescue (*Festuca scabrella*)

Habit. Long-lived, cool season, perennial bunchgrass that forms dense clumps and grows from 1 to 3 feet in height. Typically found in foothills, mountains to near timberline, benchlands and valleys. Most abundant on dry, deep sandy loam soils.

Associated species. Bluebunch wheatgrass, Idaho fescue, western needlegrass, arrowleaf balsamroot, prairie sage.

Habitat Value. Good forage value for wildlife during all growth stages. Valuable for winter grazing because it retains much of its protein and palatability.

Restoration and Erosion Control Value. No information is available, but assumed to be similar to Idaho fescue. Rough fescue will likely be slow to establish, but once established, will have abundant growth of fine leaves that provide effective ground cover, and high yields of tough, fine, fibrous roots that control erosion and improve soil structure. The presence of competitive non-native species such as cheatgrass and spotted knapweed may inhibit the growth and establishment of this species, but once established, it will resist the invasion of non-native species.

Management Implications. This species is generally favored by light to moderate grazing, but often decreases in cover and abundance under heavy grazing. Plants are not harmed by light severity fires, and typically reestablish through rapid tillering or from seed.

Sources: Stubbendieck, J. S.L. Hatch, and C.H. Butterfield 1992.

7.21 Sheep Fescue (*Festuca ovina*)

Habit. Perennial, cool season bunchgrass ranging from six to twenty-four inches in height.

Associated species. Idaho fescue, rabbitbrush, big sagebrush.

Habitat Value. Valuable forage grass for all classes of livestock. It is one of the first grasses to green in the spring. No reference to wildlife browse value, but assumed good.

Restoration and Erosion Control Considerations. Commonly used for soil erosion control, pasture, turf, watershed protection, roadside beautification, airports, dams sites, terraces, diversions, ditchbanks, mine spoils, and ski slope revegetation.

Management Implication. While resistant to drought and trampling, the absence of underground stems and lack of a strong reproduction from seed make it susceptible to overgrazing.

Source: USDA 1988.

7.22 Tufted Hairgrass (*Deschampsia cespitosa*)

Habit. Tufted hairgrass is a perennial, cool season bunchgrass found in the mountains in all of the Western States and is one of the most widely distributed of the western range grasses.

Associated Species. None listed.

Habitat Value. Tufted hairgrass is considered high quality forage for all classes of livestock.

Restoration/ Erosion Control Value. No specific information was available on the erosion control value of this species. It is noted, however, to form pure stands with almost complete ground cover on favorable sites. In addition, it has been noted as being highly tolerant to metal-contaminated soils. Also, it is adapted to a wide range of soil types.

Management Implications. New plants are established entirely from seed. Grazing practices should allow for seed to mature to ensure the sustainability of a stand.

Source: USDA 1988.

7.23 Balsamroot (*Balsamorhiza sagittata*)

Habit. Deep-rooted perennial forb common to the Intermountain West.

Associated Species. Arrowleaf balsamroot is a climax indicator in several sagebrush and grassland habitat types. It commonly grows in mixed stands with grasses, other forbs, and shrubs.

Habitat Value. Arrowleaf balsamroot provides some degree of forage for cattle, sheep, horses, pronghorn, bighorn sheep, and mule deer. On spring ranges, it is an important and palatable forage because it greens up early. Flowering heads are often preferred over the foliage. Arrowleaf balsamroot is utilized year-round but is more palatable during spring and early summer when the foliage is succulent.

Restoration and Erosion Control Considerations. Arrowleaf balsamroot is rated as having high potential for revegetation of oil shale or coal mined land, and stabilization of roadsides and other critical areas. In the Intermountain region it has only low value for soil stabilization.

Seed of arrowleaf balsamroot can be broadcast or drilled. However, because arrowleaf balsamroot is very slow growing, drilling is recommended to separate it from more competitive species. The seedbed should be firm, and the seeds should be covered after planting. Fall or winter seeding is recommended.

Seedlings of arrowleaf balsamroot are persistent on adapted sites. Seeds from a similar source should be used due to regional variation in cold tolerance.

Management implications. Following seeding, sites should not be grazed for at least two growing seasons. Establishment may take 5 to 10 years. On the best sites, plants may require 3 to 4 years to flower, and 7 to 8 years on more arid sites. When established, arrowleaf balsamroot is competitive and compatible with other species.

Source: FEIS: Fischer, William C.; Holifield, J. L. 1987.

7.24 Fireweed (*Epilobium angustifolium*)

Habit. Perennial warm season forb from one to six feet in height. Generally found in open woods, roadsides, disturbed areas in a broad range of soil types. Very abundant following fire.

Associated Species. None listed.

Habitat Value. Fireweed is utilized as browse by moose, deer and elk. In the Rocky Mountains, fireweed is an important food for elk in summer and elk sometimes feed exclusively on it. Small mammals, such as chipmunks and pikas, eat fireweed seeds. Fireweed is a nectar source for hummingbirds. Butterflies use both the nectar and pollen from fireweed.

Restoration and Erosion Control Value. Fireweed is used for revegetation of mined land and has the ability to voluntarily seed into sites when a seed source is available. Fireweed is recommended for use as protective groundcover on disturbed sites, such as roadways and logged areas. Planting fireweed rhizomes may speed colonization of a disturbed area. Dormant rhizomes have been collected and planted in simulated pipeline trenches and road rights-of-way in the Northwest Territories.

Management Implications. Fireweed is an important colonizer following vegetation disturbances in temperate climates worldwide. Fireweed enters a disturbed community and rapidly becomes abundant. In 20 study sites in Montana, it has been reported that fireweed established with about 3 percent cover 1 year after disturbance. By the second year, it peaked at about 30 percent cover and stayed around this amount for the next 8 years. Fireweed populations can maintain themselves through vegetative reproduction if conditions are not conducive to flowering.

Source: FEIS: Diane S. Pavek, December 1992.

7.25 Flax (*Linum lewisii*)

Habit. Short-lived perennial forb common to the Intermountain West.

Associated Species. None listed.

Habitat Value. Flax is considered desirable forages for deer, antelope and birds either as herbage or seed. Flax is noted to have fair forage value for livestock and wildlife during spring and winter. Birds use the seed and capsules in fall and winter. They may also provide some cover for selected small bird species.

Restoration and Erosion Control Value. Flax species are noted for their value in mixes for erosion control and beautification values.

Management Implications. None listed.

Source: USDA 1988.

7.26 Hairy Vetch (*Vicia villosa*)

Habit. Cool season, short-lived perennial legume.

Associated Species. None listed.

Habitat Value. Vetch provides excellent forage for livestock and wildlife. Mule deer, black bear, and grizzly bear browse the leaves and flowers. American vetch also provides forage for game birds and small mammals.

Restoration and Erosion Control Value. It is also useful for revegetating coal-mined lands, roadsides, and in critical-site stabilization and beautification sites. Vetch has been successfully planted in disturbed alpine rangelands in the western United States.

Management Implications. None listed.

Source: USDA 1988.

7.27 Lupine (*Lupinus argenteus*)

Habit. Perennial legume common throughout the West.

Associated Species. None listed.

Habitat Value. Lupine has been noted as being poisonous to livestock, primarily sheep and, to a lesser degree, cattle. The seeds and pods, and in some cases young plants, may sicken livestock or, in the case of heavy utilization, can prove fatal. Lupines do furnish fairly good forage for elk.

Restoration and Erosion Control Value. Lupines are valued primarily for their ability to fix nitrogen, enhancing the fertility of the soils they inhabit.

Management Implications. None listed.

Source: USDA 1988.

7.28 Lacy Phacelia (*Phacelia tanacetifolia*)

Habit. A low growing annual forb common to disturbed sites.

Associated Species. None listed.

Habitat Value. None listed.

Restoration and Erosion Control Value. Aggressive annual, adapted to a wide range of soils. Used for stabilization or beautification of disturbed sites.

Management Implications. None listed.

Source: Granite Seed, 2000

7.29 Rocky Mountain Penstemon (*Penstemon strictus*)

Habit. Perennial forb common to disturbed sites.

Associated Species. None listed.

Habitat Value. Penstemons are considered forage for deer, antelope and birds either as herbage or seed. They may also provide some cover for selected small bird species. They provide diversity to the plant community.

Restoration and Erosion Control Value. Capable of establishing on disturbed sites on a variety of soil types. All penstemon species are mentioned for their value in mixes for erosion control and beautification values.

Management Implications. None listed.

Source: USDA 1988.

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SECTION 8

COST ESTIMATE FOR RESTORATION

Section 8: Cost Estimate for Restoration

The following section identifies specific prescriptions and costs associated with the implementation of the proposed alternatives. Total costs and acreages used for estimates are located in **Table 8.1**. All costs have been adjusted for Net Present Value.

Table 8.1. Summary of Costs to Implement Alternatives.

Treatment	Acres	SSA[1] cost/acre	ARA[2] cost/acre	Total to Implement SSA	Total to Implement ARA
Bare Areas	267	$23,690[3]	$33,542	$6,325,413	$8,955,791
Steep, Degraded Grasslands	246	$14,533	$24,385	$3,581,127	$6,008,563
Degraded Grasslands	344	$9,112	$18,963	$3,138,288	$6,531,180
Steep Slope Reclamation (SSR)	54	$5,434	$8,969	$293,472	$484,363
Impacted Vegetation	1,713	$82.49	$3,595	$141,301	$6,159,670
TOTALS	**2,625**			**$13,479,605**	**$28,139,569**

[1] **SSA – Site Stabilization Alternative**

[2] **ARA – Active Restoration Alternative**

[3] **All costs listed in the above Table are adjusted for Net Present Value**

The proposed restoration plan will be implemented over 14 years. A timeline that presents the implementation schedule for restoration activities is presented in **Table 8.2**. The restoration timeline will be coordinated with remedy such that some treatments will commence following remedy, whereas other treatments are proposed to complement remedy work activities. In general, implementation of restoration for Bare Areas, Steep Degraded Grasslands, Degraded Grasslands, and Impacted Grasslands treatment areas will be conducted Years 1 through 8. SSR treatment area will begin in Year 7 and conclude at Year 14. Spreadsheets that outline further detail concerning restoration prescriptions, costs, and timeline follow **Table 8.2**.

Table 8.2. Timeline for Implementation of Restoration Activities at the Mount Haggin Injured Area.

Restoration Treatments	Year															
	1	2	3	4	5	6	7a	8a	7b	8b	9	10	11	12	13	14
Site Preparation/ Amelioration Treatments	**Bare Areas, Steep Degraded Grassland, Degraded Grassland, and Impacted Grasslands**								SSR							
Erosion Control and Sediment Retention Wattle (ESW) Installation (Specification 6.1)	X															
Aerial Application of Agricultural Lime (Specification 6.2)	X								X							
Aerial Application of Fertilizers- Initial Rate (Specification 6.5)		X								X						
Aerial Application of Compost (Specification 6.6)			X													
Seeding/ Planting Treatments																
Aerial Seeding (Specification 6.3)		X														
Aerial Application of Hydromulch (Specification 6.4)		X														
Restoration Enhancement Planting (Specification 6.7)			X	X	X	X					X	X	X	X		
Install Plant Protectors (Specification 6.8)			X	X	X	X					X	X	X	X		
Maintenance																
Aerial Application Of Fertilizers- Maintenance Rate- Year 4 (Specification 6.9)						X										
Maintenance of Erosion Control and Sediment Retention Wattles (Specification 6.10)		X	X													
Maintenance of Plant Protectors (Specification 6.11)				X	X	X	X	X				X	X	X	X	X
Replacement Plant Installation (Specification 6.12)				X	X	X	X					X	X	X	X	
Noxious Weed Control (Specification 6.13)			X	X	X	X	X				X	X	X	X	X	
Restoration Monitoring (Specification 6.14)			X	X	X	X	X				X	X	X	X	X	

8.1 Prescription: Bare Areas

Restoration Alternative: Site Stabilization

Treatment Summary: Erosion control and sediment retention wattle installation; aerial application of agricultural lime; aerial seeding; aerial application of fertilizers (initial and maintenance rate); aerial application of hydromulch; maintenance of erosion control and sediment retention wattles; noxious weed control; restoration monitoring

Year	Treatment	Rate/acre	Unit	Cost/acre
2003	Erosion control and sediment retention wattle installation:			
	Mobilization - airlift straw wattles to installation sites	1	lump sum (ls)	$460.82
	Install straw wattles on contours - 30 foot spacing	1,463	linear feet (lf)	$5,048.66
	Implementation subtotal			**$5,509.48**
	12" straw wattles	1,463	lf	$2,179.87
	Pine pin stakes	11,704	stake	$177.64
	Materials subtotal			**$2,357.51**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$165.28
	Project Management - 15% of implementation costs	1	ls	$826.42
	Contractor's Margin - 10% of material costs	1	ls	$261.95
	Contingency - 15% of total costs	1	ls	$1,368.10
	Contractor Project Fees Subtotal			**$2,621.75**
	TOTAL COST PER ACRE, EROSION CONTROL AND SEDIMENT RETENTION WATTLE INSTALLATION, YEAR 1			**$10,488.74**
2003	**Aerial application of agricultural lime:**			
	Aerial lime application	7.5	ton	$3,500.00
	Ground support - for aerial lime application	1	ls	$904.70
	Mobilization - for aerial lime application	1	ls	$82.25
	Implementation subtotal			**$4,486.95**
	Dolomitic lime	7.5	ton	$540.00
	"Soilmaster WR" - Polymer Tackifier	70	gallon	$420.00
	Materials subtotal			**$960.00**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$134.61
	Project Management - 15% of implementation costs	1	ls	$673.04
	Contractor's Margin - 10% of material costs	1	ls	$106.67
	Contingency - 15% of total costs	1	ls	$954.19
	Contractor Project Fees Subtotal			**$1,868.51**
	TOTAL COST PER ACRE, AERIAL APPLICATION OF AGRICULTURAL LIME, YEAR 1			**$7,315.46**
	TOTAL COST PER ACRE, BARE AREAS, YEAR 1			**$17,804.20**
2004	**Aerial application of seed, fertilizer, and hydromulch:**			
	Aerial seeding - dry application	1	ls	$195.16
	Aerial slurry application of fertilizer, mulch, 3 tackifiers	1	ls	$2,100.00
	Ground support - for aerial slurry application	1	ls	$904.70
	Mobilization - for aerial slurry application	1	ls	$152.65
	Implementation subtotal			**$3,352.50**
	Native grass/forb seed mixture	40	PLS pound	$720.00
	Virgin wood fiber mulch	1	ton	$320.00
	"Soilmaster WR" - Polymer Tackifier	70	gallon	$420.00
	"Finnfibers" - Fibrous Tackifier	30	pound	$75.00
	Guar Tackifier	50	pound	$85.00
	"Biosol Mix" (7-2-3) - organic fertilizer, initial rate	1	ton	$540.00
	Materials subtotal			**$2,160.00**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$100.58

8.1 Prescription: Bare Areas				
	Project Management - 15% of implementation costs	1	ls	$502.88
	Contractor's Margin - 10% of material costs	1	ls	$240.00
	Contingency - 15% of total costs	1	ls	$953.39
	Contractor Project Fees Subtotal			**$1,796.84**
	TOTAL COST PER ACRE, AERIAL APPLICATION OF FERTILIZER, SEED, AND HYDROMULCH, YEAR 2			**$7,309.35**
2004	**Maintenance of erosion control and sediment retention wattles:**			
	Maintenance of rice straw wattles - 10% of installation costs	1	ls	$262.56
	Implementation subtotal			**$262.56**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$7.88
	Project Management - 15% of implementation costs	1	ls	$39.38
	Contingency - 15% of total costs	1	ls	$46.47
	Contractor Project Fees Subtotal			**$93.73**
	TOTAL COST PER ACRE, MAINTENANCE OF EROSION CONTROL AND SEDIMENT RETENTION WATTLES, YEAR 2			**$356.30**
	TOTAL COST PER ACRE, BARE AREAS, YEAR 2			**$7,665.64**
2005	**Maintenance of erosion control and sediment retention wattles:**			
	Maintenance of rice straw wattles - 10% of installation costs	1	ls	$262.56
	Implementation subtotal			**$262.56**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$7.88
	Monitoring - 1% of implementation costs	1	ls	$2.63
	Project Management - 15% of implementation costs	1	ls	$39.38
	Contingency - 15% of total costs	1	ls	$46.87
	Contractor Project Fees Subtotal			**$96.75**
	TOTAL COST PER ACRE, MAINTENANCE OF EROSION CONTROL AND SEDIMENT RETENTION WATTLES, YEAR 3			**$359.32**
2005	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 3			**$49.83**
	TOTAL COST PER ACRE, BARE AREAS, YEAR 3			**$409.14**
2006	**Aerial application of fertilizer (maintenance rate):**			
	Aerial fertilization - dry application, maintenance rate	1	ls	$224.43
	Implementation subtotal			**$224.43**
	"Biosol Mix" (7-2-3) - organic fertilizer, maintenance rate	0.5	ton	$310.50
	Materials subtotal			**$310.50**

8.1 Prescription: Bare Areas

	Project Design and Work Plan - 3% of implementation costs	1	ls	$6.73
	Monitoring - 1.5% of implementation costs	1	ls	$2.24
	Project Management - 15% of implementation costs	1	ls	$33.66
	Contractor's Margin - 10% of material costs	1	ls	$34.50
	Contingency - 15% of total costs	1	ls	$91.81
	Contractor Project Fees Subtotal			**$168.95**
	TOTAL COST PER ACRE, AERIAL APPLICATION OF FERTILIZER (MAINTENANCE RATE), YEAR 4			**$697.15**
2006	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 4			**$49.83**
	TOTAL COST PER ACRE, BARE AREAS, YEAR 4			**$746.98**
	TOTAL COST PER ACRE, BARE AREAS (SITE STABILIZATION), ALL YEARS			**$26,625.96**
	TOTAL COST PER ACRE, BARE AREAS (SITE STABILIZATION), ALL YEARS - NET PRESENT VALUE			**$23,690.69**

8.2 Prescription: Steep, Degraded Grasslands

Restoration Alternative: Site Stabilization

Treatment Summary: Erosion control and sediment retention wattle installation; aerial application of agricultural lime; aerial seeding; aerial application of fertilizers (initial and maintenance rate); maintenance of erosion control and sediment retention wattles; noxious weed control; restoration monitoring

Year	Treatment	Rate/acre	Unit	Cost/acre
2003	**Erosion control and sediment retention wattle installation:**			
	Mobilization - airlift straw wattles to installation sites	1	lump sum (ls)	$460.82
	Install straw wattles on contours - 30 foot spacing	728	linear feet (lf)	$2,512.25
	Implementation subtotal			**$2,973.07**
	9" straw wattles	728	lf	$837.20
	Pine pin stakes	5,824	stake	$177.64
	Materials subtotal			**$1,014.84**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$89.19
	Project Management - 15% of implementation costs	1	ls	$445.96
	Contractor's Margin - 10% of material costs	1	ls	$112.76
	Contingency - 15% of total costs	1	ls	$695.37
	Contractor Project Fees Subtotal			**$1,343.29**
	TOTAL COST PER ACRE, EROSION CONTROL AND SEDIMENT RETENTION WATTLE INSTALLATION, YEAR 1			**$5,331.20**
2003	**Aerial application of agricultural lime:**			
	Aerial lime application	7.5	ton	$3,500.00
	Ground support - for aerial lime application	1	ls	$904.70
	Mobilization - for aerial lime application	1	ls	$82.25
	Implementation subtotal			**$4,486.95**
	Dolomitic lime	7.5	ton	$540.00
	"Soilmaster WR" - Polymer Tackifier	70	gallon	$420.00
	Materials subtotal			**$960.00**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$134.61
	Project Management - 15% of implementation costs	1	ls	$673.04
	Contractor's Margin - 10% of material costs	1	ls	$106.67
	Contingency - 15% of total costs	1	ls	$954.19
	Contractor Project Fees Subtotal			**$1,868.51**
	TOTAL COST PER ACRE, AERIAL APPLICATION OF AGRICULTURAL LIME, YEAR 1			**$7,315.46**
	TOTAL COST PER ACRE, STEEP, DEGRADED GRASSLANDS, YEAR 1			**$12,646.66**
2004	**Aerial application of seed and fertilizer:**			
	Aerial seeding - dry application	1	ls	$195.16
	Aerial fertilization - dry application, initial rate	1	ls	$195.16
	Implementation subtotal			**$390.32**
	Native grass/forb seed mixture	40	PLS pound	$720.00
	"Biosol Mix" (7-2-3) - organic fertilizer, initial rate	1	ton	$540.00
	Materials subtotal			**$1,260.00**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.71
	Project Management - 15% of implementation costs	1	ls	$58.55
	Contractor's Margin - 10% of material costs	1	ls	$140.00
	Contingency - 15% of total costs	1	ls	$279.09
	Contractor Project Fees Subtotal			**$489.34**
	TOTAL COST PER ACRE, AERIAL APPLICATION OF SEED AND FERTILIZER, YEAR 2			**$2,139.66**

8.2 Prescription: Steep, Degraded Grasslands				
2004	**Maintenance of erosion control and sediment retention wattles:**			
	Maintenance of rice straw wattles - 10% of installation costs	1	ls	$262.56
	Implementation subtotal			**$262.56**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$7.88
	Project Management - 15% of implementation costs	1	ls	$39.38
	Contingency - 15% of total costs	1	ls	$46.47
	Contractor Project Fees Subtotal			**$93.73**
	TOTAL COST PER ACRE, MAINTENANCE OF EROSION CONTROL AND SEDIMENT RETENTION WATTLES, YEAR 2			**$356.30**
	TOTAL COST PER ACRE, STEEP, DEGRADED GRASSLANDS, YEAR 2			**$2,495.95**
2005	**Maintenance of erosion control and sediment retention wattles:**			
	Maintenance of rice straw wattles - 10% of installation costs	1	ls	$262.56
	Implementation subtotal			**$262.56**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$7.88
	Monitoring - 1% of implementation costs	1	ls	$2.63
	Project Management - 15% of implementation costs	1	ls	$39.38
	Contingency - 15% of total costs	1	ls	$46.87
	Contractor Project Fees Subtotal			**$96.75**
	TOTAL COST PER ACRE, MAINTENANCE OF EROSION CONTROL AND SEDIMENT RETENTION WATTLES, YEAR 3			**$359.32**
2005	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 3			**$49.83**
	TOTAL COST PER ACRE, STEEP, DEGRADED GRASSLANDS, YEAR 3			**$409.14**
2006	**Aerial application of fertilizer (maintenance rate):**			
	Aerial fertilization - dry application, maintenance rate	1	ls	$224.43
	Implementation subtotal			**$224.43**
	"Biosol Mix" (7-2-3) - organic fertilizer, maintenance rate	0.5	ton	$310.50
	Materials subtotal			**$310.50**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$6.73
	Monitoring - 1.5% of implementation costs	1	ls	$2.24
	Project Management - 15% of implementation costs	1	ls	$33.66
	Contractor's Margin - 10% of material costs	1	ls	$34.50
	Contingency - 15% of total costs	1	ls	$91.81
	Contractor Project Fees Subtotal			**$168.95**

8.3 Prescription: Degraded Grasslands

Restoration Alternative: Site Stabilization

Treatment Summary: Aerial application of agricultural lime; aerial seeding; aerial application of fertilizers (initial and maintenance rate); noxious weed control; restoration monitoring

Year	Treatment	Rate/acre	Unit	Cost/acre
2003	**Aerial application of agricultural lime:**			
	Aerial lime application	7.5	ton	$3,500.00
	Ground support - for aerial lime application	1	ls	$904.70
	Mobilization - for aerial lime application	1	ls	$82.25
	Implementation subtotal			**$4,486.95**
	Dolomitic lime	7.5	ton	$540.00
	"Soilmaster WR" - Polymer Tackifier	70	gallon	$420.00
	Materials subtotal			**$960.00**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$134.61
	Project Management - 15% of implementation costs	1	ls	$673.04
	Contractor's Margin - 10% of material costs	1	ls	$106.67
	Contingency - 15% of total costs	1	ls	$954.19
	Contractor Project Fees Subtotal			**$1,868.51**
	TOTAL COST PER ACRE, AERIAL APPLICATION OF AGRICULTURAL LIME, YEAR 1			**$7,315.46**
	TOTAL COST PER ACRE, DEGRADED GRASSLANDS, YEAR 1			**$7,315.46**
2004	**Aerial application of seed and fertilizer:**			
	Aerial seeding - dry application	1	ls	$195.16
	Aerial fertilization - dry application, initial rate	1	ls	$195.16
	Implementation subtotal			**$390.32**
	Native grass/forb seed mixture	40	PLS pound	$720.00
	"Biosol Mix" (7-2-3) - organic fertilizer, initial rate	1	ton	$540.00
	Materials subtotal			**$1,260.00**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.71
	Project Management - 15% of implementation costs	1	ls	$58.55
	Contractor's Margin - 10% of material costs	1	ls	$140.00
	Contingency - 15% of total costs	1	ls	$279.09
	Contractor Project Fees Subtotal			**$489.34**
	TOTAL COST PER ACRE, AERIAL APPLICATION OF SEED AND FERTILIZER, YEAR 2			**$2,139.66**
	TOTAL COST PER ACRE, DEGRADED GRASSLANDS, YEAR 2			**$2,139.66**
2005	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 3			**$49.83**
	TOTAL COST PER ACRE, DEGRADED GRASSLANDS, YEAR 3			**$49.83**

8.3 Prescription: Degraded Grasslands				
2006	**Aerial application of fertilizer (maintenance rate):**			
	Aerial fertilization - dry application, maintenance rate	1	ls	$224.43
	Implementation subtotal			**$224.43**
	"Biosol Mix" (7-2-3) - organic fertilizer, maintenance rate	0.5	ton	$310.50
	Materials subtotal			**$310.50**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$6.73
	Monitoring - 1.5% of implementation costs	1	ls	$2.24
	Project Management - 15% of implementation costs	1	ls	$33.66
	Contractor's Margin - 10% of material costs	1	ls	$34.50
	Contingency - 15% of total costs	1	ls	$91.81
	Contractor Project Fees Subtotal			**$168.95**
	TOTAL COST PER ACRE, AERIAL APPLICATION OF FERTILIZER (MAINTENANCE RATE), YEAR 4			**$697.15**
2006	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 4			**$49.83**
	TOTAL COST PER ACRE, DEGRADED GRASSLANDS, YEAR 4			**$746.98**
	TOTAL COST PER ACRE, DEGRADED GRASSLANDS (SITE STABILIZATION), ALL YEARS			**$10,251.93**
	TOTAL COST PER ACRE, DEGRADED GRASSLANDS (SITE STABILIZATION), ALL YEARS - NET PRESENT VALUE			**$9,112.34**

8.4 Prescription: Steep Slope Reclamation (SSR)

Restoration Alternative: Site Stabilization

Treatment Summary: Aerial application of agricultural lime; noxious weed control; restoration monitoring

Year	Treatment	Rate/acre	Unit	Cost/acre
2009	**Aerial application of agricultural lime:**			
	Aerial lime application	7.5	ton	$3,500.00
	Ground support - for aerial lime application	1	ls	$904.70
	Mobilization - for aerial lime application	1	ls	$82.25
	Implementation subtotal			**$4,486.95**
	Dolomitic lime	7.5	ton	$540.00
	"Soilmaster WR" - Polymer Tackifier	70	gallon	$420.00
	Materials subtotal			**$960.00**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$134.61
	Project Management - 15% of implementation costs	1	ls	$673.04
	Contractor's Margin - 10% of material costs	1	ls	$106.67
	Contingency - 15% of total costs	1	ls	$954.19
	Contractor Project Fees Subtotal			**$1,868.51**
	TOTAL COST PER ACRE, AERIAL APPLICATION OF AGRICULTURAL LIME, YEAR 1			**$7,315.46**
	TOTAL COST PER ACRE, STEEP SLOPE RECLAMATION, YEAR 1			**$7,315.46**
2010	**TOTAL COST PER ACRE, STEEP SLOPE RECLAMATION, YEAR 2**			**$0.00**
2011	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 3			**$49.83**
	TOTAL COST PER ACRE, STEEP SLOPE RECLAMATION, YEAR 3			**$49.83**
2012	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 4			**$49.83**
	TOTAL COST PER ACRE, STEEP SLOPE RECLAMATION, YEAR 4			**$49.83**

8.4 Prescription: Steep Slope Reclamation (SSR)	
TOTAL COST PER ACRE, STEEP SLOPE RECLAMATION (SITE STABILIZATION), ALL YEARS	$7,415.12
TOTAL COST PER ACRE, STEEP SLOPE RECLAMATION (SITE STABILIZATION), ALL YEARS - NET PRESENT VALUE	$5,434.68

8.5 Prescription: Impacted Grasslands

Restoration Alternative: Site Stabilization

Treatment Summary: Noxious weed control; restoration monitoring

Year	Treatment	Rate/acre	Unit	Cost/acre
2003	TOTAL COST PER ACRE, IMPACTED GRASSLANDS, YEAR 1			$0.00
2004	TOTAL COST PER ACRE, IMPACTED GRASSLANDS, YEAR 2			$0.00
2005	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 3			**$49.83**
	TOTAL COST PER ACRE, IMPACTED GRASSLANDS YEAR 3			**$49.83**
2006	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 4			**$49.83**
	TOTAL COST PER ACRE, IMPACTED VEGETATION, YEAR 4			**$49.83**
	TOTAL COST PER ACRE, IMPACTED GRASSLANDS (SITE STABILIZATION), ALL YEARS			**$99.65**
	TOTAL COST PER ACRE, IMPACTED GRASSLANDS (SITE STABILIZATION), ALL YEARS - NET PRESENT VALUE			**$82.49**

8.6 Prescription: Bare Areas

Restoration Alternative: Active Restoration

Treatment Summary: Erosion control and sediment retention wattle installation; aerial application of agricultural lime; aerial seeding; aerial application of fertilizers (initial and maintenance rate); aerial application of compost/hydromulch;restoration enhancement planting/replants; install/maintain tree protectors; maintenance of erosion control and sediment retention wattles; noxious weed control; restoration monitoring

Year	Treatment	Rate/acre	Unit	Cost/acre
2003	**Erosion control and sediment retention wattle installation:**			
	Mobilization - airlift straw wattles to installation sites	1	lump sum (ls)	$460.82
	Install straw wattles on contours - 30 foot spacing	1,463	linear feet (lf)	$5,048.66
	Implementation subtotal			**$5,509.48**
	12" straw wattles	1,463	lf	$2,179.87
	Pine pin stakes	11,704	stake	$177.64
	Materials subtotal			**$2,357.51**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$165.28
	Project Management - 15% of implementation costs	1	ls	$826.42
	Contractor's Margin - 10% of material costs	1	ls	$261.95
	Contingency - 15% of total costs	1	ls	$1,368.10
	Contractor Project Fees Subtotal			**$2,621.75**
	TOTAL COST PER ACRE, EROSION CONTROL AND SEDIMENT RETENTION WATTLE INSTALLATION, YEAR 1			**$10,488.74**
2003	**Aerial application of agricultural lime:**			
	Aerial lime application	7.5	ton	$3,500.00
	Ground support - for aerial lime application	1	ls	$904.70
	Mobilization - for aerial lime application	1	ls	$82.25
	Implementation subtotal			**$4,486.95**
	Dolomitic lime	7.5	ton	$540.00
	"Soilmaster WR" - Polymer Tackifier	70	gallon	$420.00
	Materials subtotal			**$960.00**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$134.61
	Project Management - 15% of implementation costs	1	ls	$673.04
	Contractor's Margin - 10% of material costs	1	ls	$106.67
	Contingency - 15% of total costs	1	ls	$954.19
	Contractor Project Fees Subtotal			**$1,868.51**
	TOTAL COST PER ACRE, AERIAL APPLICATION OF AGRICULTURAL LIME, YEAR 1			**$7,315.46**
	TOTAL COST PER ACRE, BARE AREAS, YEAR 1			**$17,804.20**
2004	**Aerial application of seed, fertilizer, and hydromulch:**			
	Aerial seeding - dry application	1	ls	$195.16
	Aerial slurry application of fertilizer, mulch, 3 tackifiers	1	ls	$2,100.00
	Ground support - for aerial slurry application	1	ls	$904.70
	Mobilization - for aerial slurry application	1	ls	$152.65
	Implementation subtotal			**$3,352.50**
	Native grass/forb seed mixture	40	PLS pound	$720.00
	Virgin wood fiber mulch	1	ton	$320.00
	"Soilmaster WR" - Polymer Tackifier	70	gallon	$420.00
	"Finnfibers" - Fibrous Tackifier	30	pound	$75.00
	Guar Tackifier	50	pound	$85.00
	"Biosol Mix" (7-2-3) - organic fertilizer, initial rate	1	ton	$540.00
	Materials subtotal			**$2,160.00**

8.6 Prescription: Bare Areas

	Project Design and Work Plan - 3% of implementation costs	1	ls	$100.58
	Project Management - 15% of implementation costs	1	ls	$502.88
	Contractor's Margin - 10% of material costs	1	ls	$240.00
	Contingency - 15% of total costs	1	ls	$953.39
	Contractor Project Fees Subtotal			**$1,796.84**
	TOTAL COST PER ACRE, AERIAL APPLICATION OF SEED, FERTILIZER, AND HYDROMULCH, YEAR 2			**$7,309.35**
2004	**Maintenance of erosion control and sediment retention wattles:**			
	Maintenance of rice straw wattles - 10% of installation costs	1	ls	$262.56
	Implementation subtotal			**$262.56**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$7.88
	Project Management - 15% of implementation costs	1	ls	$39.38
	Contingency - 15% of total costs	1	ls	$46.47
	Contractor Project Fees Subtotal			**$93.73**
	TOTAL COST PER ACRE, MAINTENANCE OF EROSION CONTROL AND SEDIMENT RETENTION WATTLES, YEAR 2			**$356.30**
	TOTAL COST PER ACRE, BARE AREAS, YEAR 2			**$7,665.64**
2005	**Aerial application of compost:**			
	Aerial compost application	1	ls	$3,197.21
	Implementation subtotal			**$3,197.21**
	Pelletized compost	34	cubic yards	$2,478.60
	Materials subtotal			**$2,478.60**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$95.92
	Monitoring - 1% of implementation costs	1	ls	$31.97
	Project Management - 15% of implementation costs	1	ls	$479.58
	Contractor's Margin - 10% of material costs	1	ls	$275.40
	Contingency - 15% of total costs	1	ls	$983.80
	Contractor Project Fees Subtotal			**$1,866.67**
	TOTAL COST PER ACRE, AERIAL APPLICATION OF COMPOST, YEAR 3			**$7,542.48**
2005	**Restoration enhancement planting:**			
	Airlift planting supplies to installation sites	1	ls	$17.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors	1	ls	$372.66
	Implementation subtotal			**$390.16**
	Containerized seedlings	500	seedlings	$143.75
	"Bio-Pak" (16-6-8 + minors) slow release fertilizer, 1 packet/seedling	500	packet	$7.50
	Pelletized compost - 1 pint/seedling	500	pint	$6.48
	"Treepro Junior" - 4"x12" plant protector, 1	500	protector	$57.50
	Materials subtotal			**$215.23**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.70
	Monitoring - 1% of implementation costs	1	ls	$3.90
	Project Management - 15% of implementation costs	1	ls	$58.52
	Contractor's Margin - 10% of material costs	1	ls	$23.91
	Contingency - 15% of total costs	1	ls	$105.51
	Contractor Project Fees Subtotal			**$203.56**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 3			**$808.94**

8.6 Prescription: Bare Areas				
2005	**Maintenance of erosion control and sediment retention wattles:**			
	Maintenance of rice straw wattles - 10% of installation costs	1	ls	$262.56
	Implementation subtotal			**$262.56**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$7.88
	Monitoring - 1% of implementation costs	1	ls	$2.63
	Project Management - 15% of implementation costs	1	ls	$39.38
	Contingency - 15% of total costs	1	ls	$46.87
	Contractor Project Fees Subtotal			**$96.75**
	TOTAL COST PER ACRE, MAINTENANCE OF EROSION CONTROL AND SEDIMENT RETENTION WATTLES, YEAR 3			**$359.32**
2005	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 3			**$49.83**
	TOTAL COST PER ACRE, BARE AREAS, YEAR 3			**$8,760.57**
2006	**Restoration enhancement planting:**			
	Airlift planting supplies to installation sites	1	ls	$17.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors	1	ls	$372.66
	Implementation subtotal			**$390.16**
	Containerized seedlings	500	seedlings	$143.75
	"Bio-Pak" (16-6-8 + minors) slow release fertilizer, 1	500	packet	$7.50
	Pelletized compost - 1 pint/seedling	500	pint	$6.48
	"Treepro Junior" - 4"x12" plant protector, 1	500	protector	$57.50
	Materials subtotal			**$215.23**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.70
	Monitoring - 1% of implementation costs	1	ls	$3.90
	Project Management - 15% of implementation costs	1	ls	$58.52
	Contractor's Margin - 10% of material costs	1	ls	$23.91
	Contingency - 15% of total costs	1	ls	$105.51
	Contractor Project Fees Subtotal			**$203.56**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 4			**$808.94**
2006	**Replacement plant installation:**			
	Airlift replanting supplies to installation sites - 20% of Year 3	1	ls	$3.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors - 20% of Year 3 planting	1	ls	$74.53
	Implementation subtotal			**$78.03**
	Replacement containerized seedlings - 20% of Year 3 totals	1	ls	$28.75
	Replacement plant proctectors and amendments	1	ls	$14.30
	Materials subtotal			**$43.05**

8.6 Prescription: Bare Areas				
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.34
	Monitoring - 1% of implementation costs	1	ls	$0.78
	Project Management - 15% of implementation costs	1	ls	$11.70
	Contractor's Margin - 10% of material costs	1	ls	$4.78
	Contingency - 15% of total costs	1	ls	$21.10
	Contractor Project Fees Subtotal			**$40.71**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 4			**$161.79**
2006	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Year 3 planting costs	1	ls	$37.27
	Implementation subtotal			**$37.27**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$1.12
	Monitoring - 1% of implementation costs	1	ls	$0.37
	Project Management - 15% of implementation costs	1	ls	$5.59
	Contingency - 15% of total costs	1	ls	$6.65
	Contractor Project Fees Subtotal			**$13.73**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 4			**$51.00**
2006	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 4			**$49.83**
	TOTAL COST PER ACRE, BARE AREAS, YEAR 4			**$1,071.56**
2007	**Restoration enhancement planting:**			
	Airlift planting supplies to installation sites	1	ls	$17.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors	1	ls	$372.66
	Implementation subtotal			**$390.16**
	Containerized seedlings	500	seedlings	$143.75
	"Bio-Pak" (16-6-8 + minors) slow release fertilizer, 1 packet/seedling	500	packet	$7.50
	Pelletized compost - 1 pint/seedling	500	pint	$6.48
	"Treepro Junior" - 4"x12" plant protector, 1	500	protector	$57.50
	Materials subtotal			**$215.23**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.70
	Monitoring - 1% of implementation costs	1	ls	$3.90
	Project Management - 15% of implementation costs	1	ls	$58.52
	Contractor's Margin - 10% of material costs	1	ls	$23.91
	Contingency - 15% of total costs	1	ls	$105.51
	Contractor Project Fees Subtotal			**$203.56**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 5			**$808.94**

8.6 Prescription: Bare Areas

2007	**Replacement plant installation:**			
	Airlift replanting supplies to installation sites - 20% of Year 4	1	ls	$3.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors - 20% of Year 4 planting	1	ls	$74.53
	Implementation subtotal			**$78.03**
	Replacement containerized seedlings - 20% of Year 3 totals	1	ls	$28.75
	Replacement plant proctectors and amendments	1	ls	$14.30
	Materials subtotal			**$43.05**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.34
	Monitoring - 1% of implementation costs	1	ls	$0.78
	Project Management - 15% of implementation costs	1	ls	$11.70
	Contractor's Margin - 10% of material costs	1	ls	$4.78
	Contingency - 15% of total costs	1	ls	$21.10
	Contractor Project Fees Subtotal			**$40.71**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 5			**$161.79**
2007	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Years 3 and 4	1	ls	$74.53
	Implementation subtotal			**$74.53**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.24
	Monitoring - 1% of implementation costs	1	ls	$0.75
	Project Management - 15% of implementation costs	1	ls	$11.18
	Contingency - 15% of total costs	1	ls	$13.30
	Contractor Project Fees Subtotal			**$27.47**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 5			**$102.00**
2007	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 5			**$49.83**
	TOTAL COST PER ACRE, BARE AREAS, YEAR 5			**$1,122.56**
2008	**Restoration enhancement planting:**			
	Airlift planting supplies to installation sites	1	ls	$17.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors	1	ls	$372.66
	Implementation subtotal			**$390.16**
	Containerized seedlings	500	seedlings	$143.75
	"Bio-Pak" (16-6-8 + minors) slow release fertilizer, 1 packet/seedling	500	packet	$7.50
	Pelletized compost - 1 pint/seedling	500	pint	$6.48
	"Treepro Junior" - 4"x12" plant protector, 1	500	protector	$57.50
	Materials subtotal			**$215.23**

8.6 Prescription: Bare Areas				
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.70
	Monitoring - 1% of implementation costs	1	ls	$3.90
	Project Management - 15% of implementation costs	1	ls	$58.52
	Contractor's Margin - 10% of material costs	1	ls	$23.91
	Contingency - 15% of total costs	1	ls	$105.51
	Contractor Project Fees Subtotal			**$203.56**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 6			**$808.94**
2008	**Replacement plant installation:**			
	Airlift replanting supplies to installation sites - 20% of Year 5 airlift costs	1	ls	$3.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors - 20% of Year 5 planting	1	ls	$74.53
	Implementation subtotal			**$78.03**
	Replacement containerized seedlings - 20% of Year 3 totals	1	ls	$28.75
	Replacement plant proctectors and amendments	1	ls	$14.30
	Materials subtotal			**$43.05**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.34
	Monitoring - 1% of implementation costs	1	ls	$0.78
	Project Management - 15% of implementation costs	1	ls	$11.70
	Contractor's Margin - 10% of material costs	1	ls	$4.78
	Contingency - 15% of total costs	1	ls	$21.10
	Contractor Project Fees Subtotal			**$40.71**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 6			**$161.79**
2008	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Years 4 and 5 planting costs	1	ls	$74.53
	Implementation subtotal			**$74.53**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.24
	Monitoring - 1% of implementation costs	1	ls	$0.75
	Project Management - 15% of implementation costs	1	ls	$11.18
	Contingency - 15% of total costs	1	ls	$13.30
	Contractor Project Fees Subtotal			**$27.47**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 6			**$102.00**
2008	**Aerial application of fertilizer (maintenance rate):**			
	Aerial fertilization - dry application, maintenance rate	1	ls	$243.95
	Implementation subtotal			**$243.95**
	"Biosol Mix" (7-2-3) - organic fertilizer, maintenance rate	0.5	ton	$310.50
	Materials subtotal			**$310.50**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$7.32
	Monitoring - 1.5% of implementation costs	1	ls	$2.44
	Project Management - 15% of implementation costs	1	ls	$36.59
	Contractor's Margin - 10% of material costs	1	ls	$34.50
	Contingency - 15% of total costs	1	ls	$95.29
	Contractor Project Fees Subtotal			**$176.14**
	TOTAL COST PER ACRE, AERIAL APPLICATION OF FERTILIZER (MAINTENANCE			**$730.59**
2008	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**

8.6 Prescription: Bare Areas				
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 6			**$49.83**
	TOTAL COST PER ACRE, BARE AREAS, YEAR 6			**$1,853.15**
2009	**Replacement plant installation:**			
	Airlift replanting supplies to installation sites - 20% of Year 6 airlift costs	1	ls	$3.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors - 20% of Year 6 planting	1	ls	$74.53
	Implementation subtotal			**$78.03**
	Replacement containerized seedlings - 20% of Year 3 totals	1	ls	$28.75
	Replacement plant proctectors and amendments	1	ls	$14.30
	Materials subtotal			**$43.05**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.34
	Monitoring - 1% of implementation costs	1	ls	$0.78
	Project Management - 15% of implementation costs	1	ls	$11.70
	Contractor's Margin - 10% of material costs	1	ls	$4.78
	Contingency - 15% of total costs	1	ls	$21.10
	Contractor Project Fees Subtotal			**$40.71**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 7			**$161.79**
2009	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Years 5 and 6	1	ls	$74.53
	Implementation subtotal			**$74.53**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.24
	Monitoring - 1% of implementation costs	1	ls	$0.75
	Project Management - 15% of implementation costs	1	ls	$11.18
	Contingency - 15% of total costs	1	ls	$13.30
	Contractor Project Fees Subtotal			**$27.47**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 7			**$102.00**
2009	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 7			**$49.83**

8.6 Prescription: Bare Areas				
	TOTAL COST PER ACRE, BARE AREAS, YEAR 7			**$313.61**
2010	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Years 6 and 7 planting costs	1	ls	$37.27
	Implementation subtotal			**$37.27**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$1.12
	Monitoring - 1% of implementation costs	1	ls	$0.37
	Project Management - 15% of implementation costs	1	ls	$5.59
	Contingency - 15% of total costs	1	ls	$6.65
	Contractor Project Fees Subtotal			**$13.73**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 8			**$51.00**
	TOTAL COST PER ACRE, BARE AREAS, YEAR 8			**$51.00**
	TOTAL COST PER ACRE, BARE AREAS (ACTIVE RESTORATION), ALL YEARS			**$38,642.28**
	TOTAL COST PER ACRE, BARE AREAS (ACTIVE RESTORATION), ALL YEARS - NET PRESENT VALUE			**$33,542.29**

8.7 Prescription: Steep, Degraded Grasslands

Restoration Alternative: Active Restoration

Treatment Summary: Erosion control and sediment retention wattle installation; aerial application of agricultural lime; aerial seeding; aerial application of fertilizers (initial and maintenance rate); aerial application of compost;restoration enhancement planting/replants; install/maintain tree protectors maintenance of erosion control and sediment retention wattles;noxious weed control; restoration monitoring

Year	Treatment	Rate/acre	Unit	Cost/acre
2003	**Erosion control and sediment retention wattle installation:**			
	Mobilization - airlift straw wattles to installation sites	1	lump sum (ls)	$460.82
	Install straw wattles on contours - 30 foot spacing	728	linear feet (lf)	$2,512.25
	Implementation subtotal			**$2,973.07**
	9" straw wattles	728	lf	$837.20
	Pine pin stakes	5,824	stake	$177.64
	Materials subtotal			**$1,014.84**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$89.19
	Project Management - 15% of implementation costs	1	ls	$445.96
	Contractor's Margin - 10% of material costs	1	ls	$112.76
	Contingency - 15% of total costs	1	ls	$695.37
	Contractor Project Fees Subtotal			**$1,343.29**
	TOTAL COST PER ACRE, EROSION CONTROL AND SEDIMENT RETENTION WATTLE INSTALLATION, YEAR 1			**$5,331.20**
2003	**Aerial application of agricultural lime:**			
	Aerial lime application	7.5	ton	$3,500.00
	Ground support - for aerial lime application	1	ls	$904.70
	Mobilization - for aerial lime application	1	ls	$82.25
	Implementation subtotal			**$4,486.95**
	Dolomitic lime	7.5	ton	$540.00
	"Soilmaster WR" - Polymer Tackifier	70	gallon	$420.00
	Materials subtotal			**$960.00**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$134.61
	Project Management - 15% of implementation costs	1	ls	$673.04
	Contractor's Margin - 10% of material costs	1	ls	$106.67
	Contingency - 15% of total costs	1	ls	$954.19
	Contractor Project Fees Subtotal			**$1,868.51**
	TOTAL COST PER ACRE, AERIAL APPLICATION OF AGRICULTURAL LIME, YEAR 1			**$7,315.46**
	TOTAL COST PER ACRE, STEEP, DEGRADED GRASSLANDS, YEAR 1			**$12,646.66**
2004	**Aerial application of seed and fertilizer:**			
	Aerial seeding - dry application	1	ls	$195.16
	Aerial fertilization - dry application, initial rate	1	ls	$195.16
	Implementation subtotal			**$390.32**
	Native grass/forb seed mixture	40	PLS pound	$720.00
	"Biosol Mix" (7-2-3) - organic fertilizer, initial rate	1	ton	$540.00
	Materials subtotal			**$1,260.00**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.71
	Project Management - 15% of implementation costs	1	ls	$58.55
	Contractor's Margin - 10% of material costs	1	ls	$140.00
	Contingency - 15% of total costs	1	ls	$279.09
	Contractor Project Fees Subtotal			**$489.34**

8.7 Prescription: Steep, Degraded Grasslands				
	TOTAL COST PER ACRE, AERIAL APPLICATION OF SEED AND FERTILIZER, YEAR 2			**$2,139.66**
2004	**Maintenance of erosion control and sediment retention wattles:**			
	Maintenance of rice straw wattles - 10% of installation costs	1	ls	$262.56
	Implementation subtotal			**$262.56**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$7.88
	Project Management - 15% of implementation costs	1	ls	$39.38
	Contingency - 15% of total costs	1	ls	$46.47
	Contractor Project Fees Subtotal			**$93.73**
	TOTAL COST PER ACRE, MAINTENANCE OF EROSION CONTROL AND SEDIMENT RETENTION WATTLES, YEAR 2			**$356.30**
	TOTAL COST PER ACRE, STEEP, DEGRADED GRASSLANDS, YEAR 2			**$2,495.95**
2005	**Aerial application of compost:**			
	Aerial compost application	1	ls	$3,197.21
	Implementation subtotal			**$3,197.21**
	Pelletized compost	34	cubic yards	$2,478.60
	Materials subtotal			**$2,478.60**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$95.92
	Monitoring - 1% of implementation costs	1	ls	$31.97
	Project Management - 15% of implementation costs	1	ls	$479.58
	Contractor's Margin - 10% of material costs	1	ls	$275.40
	Contingency - 15% of total costs	1	ls	$983.80
	Contractor Project Fees Subtotal			**$1,866.67**
	TOTAL COST PER ACRE, AERIAL APPLICATION OF COMPOST, YEAR 3			**$7,542.48**
2005	**Restoration enhancement planting:**			
	Airlift planting supplies to installation sites	1	ls	$17.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors	1	ls	$372.66
	Implementation subtotal			**$390.16**
	Containerized seedlings	500	seedlings	$143.75
	"Bio-Pak" (16-6-8 + minors) slow release fertilizer, 1 packet/seedling	500	packet	$7.50
	Pelletized compost - 1 pint/seedling	500	pint	$6.48
	"Treepro Junior" - 4"x12" plant protector, 1	500	protector	$57.50
	Materials subtotal			**$215.23**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.70
	Monitoring - 1% of implementation costs	1	ls	$3.90
	Project Management - 15% of implementation costs	1	ls	$58.52
	Contractor's Margin - 10% of material costs	1	ls	$23.91
	Contingency - 15% of total costs	1	ls	$105.51
	Contractor Project Fees Subtotal			**$203.56**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 3			**$808.94**
2005	**Maintenance of erosion control and sediment retention wattles:**			
	Maintenance of rice straw wattles - 10% of installation costs	1	ls	$262.56
	Implementation subtotal			**$262.56**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$7.88
	Monitoring - 1% of implementation costs	1	ls	$2.63

8.7 Prescription: Steep, Degraded Grasslands				
	Project Management - 15% of implementation costs	1	ls	$39.38
	Contingency - 15% of total costs	1	ls	$46.87
	Contractor Project Fees Subtotal			**$96.75**
	TOTAL COST PER ACRE, MAINTENANCE OF EROSION CONTROL AND SEDIMENT			**$359.32**
2005	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 3			**$49.83**
	TOTAL COST PER ACRE, STEEP, DEGRADED GRASSLANDS, YEAR 3			**$8,760.57**
2006	**Restoration enhancement planting:**			
	Airlift planting supplies to installation sites	1	ls	$17.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors	1	ls	$372.66
	Implementation subtotal			**$390.16**
	Containerized seedlings	500	seedlings	$143.75
	"Bio-Pak" (16-6-8 + minors) slow release fertilizer, 1 packet/seedling	500	packet	$7.50
	Pelletized compost - 1 pint/seedling	500	pint	$6.48
	"Treepro Junior" - 4"x12" plant protector, 1	500	protector	$57.50
	Materials subtotal			**$215.23**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.70
	Monitoring - 1% of implementation costs	1	ls	$3.90
	Project Management - 15% of implementation costs	1	ls	$58.52
	Contractor's Margin - 10% of material costs	1	ls	$23.91
	Contingency - 15% of total costs	1	ls	$105.51
	Contractor Project Fees Subtotal			**$203.56**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 4			**$808.94**
2006	**Replacement plant installation:**			
	Airlift replanting supplies to installation sites - 20% of Year 3 airlift costs	1	ls	$3.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors - 20% of Year 3 planting	1	ls	$74.53
	Implementation subtotal			**$78.03**
	Replacement containerized seedlings - 20% of Year 3 totals	1	ls	$28.75
	Replacement plant proctectors and amendments	1	ls	$14.30
	Materials subtotal			**$43.05**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.34
	Monitoring - 1% of implementation costs	1	ls	$0.78
	Project Management - 15% of implementation costs	1	ls	$11.70
	Contractor's Margin - 10% of material costs	1	ls	$4.78
	Contingency - 15% of total costs	1	ls	$21.10

8.7 Prescription: Steep, Degraded Grasslands

	Contractor Project Fees Subtotal			**$40.71**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 4			**$161.79**
2006	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Year 3 planting costs	1	ls	$37.27
	Implementation subtotal			**$37.27**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$1.12
	Monitoring - 1% of implementation costs	1	ls	$0.37
	Project Management - 15% of implementation costs	1	ls	$5.59
	Contingency - 15% of total costs	1	ls	$6.65
	Contractor Project Fees Subtotal			**$13.73**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 4			**$51.00**
2006	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 4			**$49.83**
	TOTAL COST PER ACRE, STEEP, DEGRADED GRASSLANDS, YEAR 4			**$1,071.56**
2007	**Restoration enhancement planting:**			
	Airlift planting supplies to installation sites	1	ls	$17.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors	1	ls	$372.66
	Implementation subtotal			**$390.16**
	Containerized seedlings	500	seedlings	$143.75
	"Bio-Pak" (16-6-8 + minors) slow release fertilizer, 1	500	packet	$7.50
	Pelletized compost - 1 pint/seedling	500	pint	$6.48
	"Treepro Junior" - 4"x12" plant protector, 1	500	protector	$57.50
	Materials subtotal			**$215.23**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.70
	Monitoring - 1% of implementation costs	1	ls	$3.90
	Project Management - 15% of implementation costs	1	ls	$58.52
	Contractor's Margin - 10% of material costs	1	ls	$23.91
	Contingency - 15% of total costs	1	ls	$105.51
	Contractor Project Fees Subtotal			**$203.56**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 5			**$808.94**
2007	**Replacement plant installation:**			
	Airlift replanting supplies to installation sites - 20% of Year 4 airlift costs	1	ls	$3.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors - 20% of Year 4 planting	1	ls	$74.53

8.7 Prescription: Steep, Degraded Grasslands

	Implementation subtotal			**$78.03**
	Replacement containerized seedlings - 20% of Year 3 totals	1	ls	$28.75
	Replacement plant proctectors and amendments	1	ls	$14.30
	Materials subtotal			**$43.05**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.34
	Monitoring - 1% of implementation costs	1	ls	$0.78
	Project Management - 15% of implementation costs	1	ls	$11.70
	Contractor's Margin - 10% of material costs	1	ls	$4.78
	Contingency - 15% of total costs	1	ls	$21.10
	Contractor Project Fees Subtotal			**$40.71**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 5			**$161.79**
2007	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Years 3 and 4 planting costs	1	ls	$74.53
	Implementation subtotal			**$74.53**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.24
	Monitoring - 1% of implementation costs	1	ls	$0.75
	Project Management - 15% of implementation costs	1	ls	$11.18
	Contingency - 15% of total costs	1	ls	$13.30
	Contractor Project Fees Subtotal			**$27.47**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 5			**$102.00**
2007	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 5			**$49.83**
	TOTAL COST PER ACRE, STEEP, DEGRADED GRASSLANDS, YEAR 5			**$1,122.56**
2008	**Restoration enhancement planting:**			
	Airlift planting supplies to installation sites	1	ls	$17.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors	1	ls	$372.66
	Implementation subtotal			**$390.16**
	Containerized seedlings	500	seedlings	$143.75
	"Bio-Pak" (16-6-8 + minors) slow release fertilizer, 1	500	packet	$7.50
	Pelletized compost - 1 pint/seedling	500	pint	$6.48
	"Treepro Junior" - 4"x12" plant protector, 1	500	protector	$57.50
	Materials subtotal			**$215.23**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.70
	Monitoring - 1% of implementation costs	1	ls	$3.90
	Project Management - 15% of implementation costs	1	ls	$58.52
	Contractor's Margin - 10% of material costs	1	ls	$23.91
	Contingency - 15% of total costs	1	ls	$105.51

8.7 Prescription: Steep, Degraded Grasslands

	Contractor Project Fees Subtotal			**$203.56**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 6			**$808.94**
2008	**Replacement plant installation:**			
	Airlift replanting supplies to installation sites - 20% of Year 5 airlift costs	1	ls	$3.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors - 20% of Year 5 planting	1	ls	$74.53
	Implementation subtotal			**$78.03**
	Replacement containerized seedlings - 20% of Year 3 totals	1	ls	$28.75
	Replacement plant proctectors and amendments	1	ls	$14.30
	Materials subtotal			**$43.05**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.34
	Monitoring - 1% of implementation costs	1	ls	$0.78
	Project Management - 15% of implementation costs	1	ls	$11.70
	Contractor's Margin - 10% of material costs	1	ls	$4.78
	Contingency - 15% of total costs	1	ls	$21.10
	Contractor Project Fees Subtotal			**$40.71**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 6			**$161.79**
2008	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Years 4 and 5	1	ls	$74.53
	Implementation subtotal			**$74.53**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.24
	Monitoring - 1% of implementation costs	1	ls	$0.75
	Project Management - 15% of implementation costs	1	ls	$11.18
	Contingency - 15% of total costs	1	ls	$13.30
	Contractor Project Fees Subtotal			**$27.47**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 6			**$102.00**
2008	**Aerial application of fertilizer (maintenance rate):**			
	Aerial fertilization - dry application, maintenance rate	1	ls	$243.95
	Implementation subtotal			**$243.95**
	"Biosol Mix" (7-2-3) - organic fertilizer, maintenance rate	0.5	ton	$310.50
	Materials subtotal			**$310.50**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$7.32
	Monitoring - 1.5% of implementation costs	1	ls	$2.44
	Project Management - 15% of implementation costs	1	ls	$36.59
	Contractor's Margin - 10% of material costs	1	ls	$34.50
	Contingency - 15% of total costs	1	ls	$95.29
	Contractor Project Fees Subtotal			**$176.14**
	TOTAL COST PER ACRE, AERIAL APPLICATION OF FERTILIZER (MAINTENANCE RATE), YEAR 6			**$730.59**
2008	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11

8.7 Prescription: Steep, Degraded Grasslands				
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 6			**$49.83**
	TOTAL COST PER ACRE, STEEP, DEGRADED GRASSLANDS, YEAR 6			**$1,853.15**
2009	**Replacement plant installation:**			
	Airlift replanting supplies to installation sites - 20% of Year 6 airlift costs	1	ls	$3.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors - 20% of Year 6 planting	1	ls	$74.53
	Implementation subtotal			**$78.03**
	Replacement containerized seedlings - 20% of Year 3 totals	1	ls	$28.75
	Replacement plant proctectors and amendments	1	ls	$14.30
	Materials subtotal			**$43.05**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.34
	Monitoring - 1% of implementation costs	1	ls	$0.78
	Project Management - 15% of implementation costs	1	ls	$11.70
	Contractor's Margin - 10% of material costs	1	ls	$4.78
	Contingency - 15% of total costs	1	ls	$21.10
	Contractor Project Fees Subtotal			**$40.71**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 7			**$161.79**
2009	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Years 5 and 6 planting costs	1	ls	$74.53
	Implementation subtotal			**$74.53**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.24
	Monitoring - 1% of implementation costs	1	ls	$0.75
	Project Management - 15% of implementation costs	1	ls	$11.18
	Contingency - 15% of total costs	1	ls	$13.30
	Contractor Project Fees Subtotal			**$27.47**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 7			**$102.00**
2009	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 7			**$49.83**
	TOTAL COST PER ACRE, STEEP, DEGRADED GRASSLANDS, YEAR 7			**$313.61**
2010	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Years 6 and 7 planting costs	1	ls	$37.27

8.7 Prescription: Steep, Degraded Grasslands			
Implementation subtotal			**$37.27**
Project Design and Work Plan - 3% of implementation costs	1	ls	$1.12
Monitoring - 1% of implementation costs	1	ls	$0.37
Project Management - 15% of implementation costs	1	ls	$5.59
Contingency - 15% of total costs	1	ls	$6.65
Contractor Project Fees Subtotal			**$13.73**
TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 8			**$51.00**
TOTAL COST PER ACRE, STEEP, DEGRADED GRASSLANDS, YEAR 8			**$51.00**
TOTAL COST PER ACRE, STEEP, DEGRADED GRASSLANDS (ACTIVE RESTORATION), ALL YEARS			**$28,315.06**
TOTAL COST PER ACRE, STEEP, DEGRADED GRASSLANDS (ACTIVE RESTORATION), ALL YEARS - NET PRESENT VALUE			**$24,385.40**

8.8 Prescription: Degraded Grasslands

Restoration Alternative: Active Restoration

Treatment Summary: Aerial application of agricultural lime; aerial seeding; aerial application of fertilizers (initial and maintenance rate); aerial application of compost; restoration enhancement planting/replants; install/maintain tree protectors; noxious weed control; restoration monitoring.

Year	Treatment	Rate/acre	Unit	Cost/acre
2003	**Aerial application of agricultural lime:**			
	Aerial lime application	7.5	ton	$3,500.00
	Ground support - for aerial lime application	1	ls	$904.70
	Mobilization - for aerial lime application	1	ls	$82.25
	Implementation subtotal			**$4,486.95**
	Dolomitic lime	7.5	ton	$540.00
	"Soilmaster WR" - Polymer Tackifier	70	gallon	$420.00
	Materials subtotal			**$960.00**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$134.61
	Project Management - 15% of implementation costs	1	ls	$673.04
	Contractor's Margin - 10% of material costs	1	ls	$106.67
	Contingency - 15% of total costs	1	ls	$954.19
	Contractor Project Fees Subtotal			**$1,868.51**
	TOTAL COST PER ACRE, AERIAL APPLICATION OF AGRICULTURAL LIME, YEAR 1			**$7,315.46**
	TOTAL COST PER ACRE, DEGRADED GRASSLANDS, YEAR 1			**$7,315.46**
2004	**Aerial application of seed and fertilizer:**			
	Aerial seeding - dry application	1	ls	$195.16
	Aerial fertilization - dry application, initial rate	1	ls	$195.16
	Implementation subtotal			**$390.32**
	Native grass/forb seed mixture	40	PLS pound	$720.00
	"Biosol Mix" (7-2-3) - organic fertilizer, initial rate	1	ton	$540.00
	Materials subtotal			**$1,260.00**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.71
	Project Management - 15% of implementation costs	1	ls	$58.55
	Contractor's Margin - 10% of material costs	1	ls	$140.00
	Contingency - 15% of total costs	1	ls	$279.09
	Contractor Project Fees Subtotal			**$489.34**
	TOTAL COST PER ACRE, AERIAL APPLICATION OF SEED AND FERTILIZER, YEAR 2			**$2,139.66**
	TOTAL COST PER ACRE, DEGRADED GRASSLANDS, YEAR 2			**$2,139.66**
2005	**Aerial application of compost:**			
	Aerial compost application	1	ls	$3,197.21
	Implementation subtotal			**$3,197.21**
	Pelletized compost	34	cubic yards	$2,478.60
	Materials subtotal			**$2,478.60**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$95.92
	Monitoring - 1% of implementation costs	1	ls	$31.97
	Project Management - 15% of implementation costs	1	ls	$479.58
	Contractor's Margin - 10% of material costs	1	ls	$275.40
	Contingency - 15% of total costs	1	ls	$983.80
	Contractor Project Fees Subtotal			**$1,866.67**
	TOTAL COST PER ACRE, AERIAL APPLICATION OF COMPOST, YEAR 3			**$7,542.48**

8.8 Prescription: Degraded Grasslands

2005	**Restoration enhancement planting:**			
	Airlift planting supplies to installation sites	1	ls	$17.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors	1	ls	$372.66
	Implementation subtotal			**$390.16**
	Containerized seedlings	500	seedlings	$143.75
	"Bio-Pak" (16-6-8 + minors) slow release fertilizer, 1 packet/seedling	500	packet	$7.50
	Pelletized compost - 1 pint/seedling	500	pint	$6.48
	"Treepro Junior" - 4"x12" plant protector, 1	500	protector	$57.50
	Materials subtotal			**$215.23**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.70
	Monitoring - 1% of implementation costs	1	ls	$3.90
	Project Management - 15% of implementation costs	1	ls	$58.52
	Contractor's Margin - 10% of material costs	1	ls	$23.91
	Contingency - 15% of total costs	1	ls	$105.51
	Contractor Project Fees Subtotal			**$203.56**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 3			**$808.94**
2005	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 3			**$49.83**
	TOTAL COST PER ACRE, DEGRADED GRASSLANDS, YEAR 3			**$8,401.25**
2006	**Restoration enhancement planting:**			
	Airlift planting supplies to installation sites	1	ls	$17.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors	1	ls	$372.66
	Implementation subtotal			**$390.16**
	Containerized seedlings	500	seedlings	$143.75
	"Bio-Pak" (16-6-8 + minors) slow release fertilizer, 1 packet/seedling	500	packet	$7.50
	Pelletized compost - 1 pint/seedling	500	pint	$6.48
	"Treepro Junior" - 4"x12" plant protector, 1	500	protector	$57.50
	Materials subtotal			**$215.23**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.70
	Monitoring - 1% of implementation costs	1	ls	$3.90
	Project Management - 15% of implementation costs	1	ls	$58.52
	Contractor's Margin - 10% of material costs	1	ls	$23.91
	Contingency - 15% of total costs	1	ls	$105.51
	Contractor Project Fees Subtotal			**$203.56**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 4			**$808.94**

8.8 Prescription: Degraded Grasslands				
2006	**Replacement plant installation:**			
	Airlift replanting supplies to installation sites - 20% of Year 3 airlift costs	1	ls	$3.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors - 20% of Year 3 planting	1	ls	$74.53
	Implementation subtotal			**$78.03**
	Replacement containerized seedlings - 20% of Year 3 totals	1	ls	$28.75
	Replacement plant proctectors and amendments	1	ls	$14.30
	Materials subtotal			**$43.05**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.34
	Monitoring - 1% of implementation costs	1	ls	$0.78
	Project Management - 15% of implementation costs	1	ls	$11.70
	Contractor's Margin - 10% of material costs	1	ls	$4.78
	Contingency - 15% of total costs	1	ls	$21.10
	Contractor Project Fees Subtotal			**$40.71**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 4			**$161.79**
2006	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Year 3 planting costs	1	ls	$37.27
	Implementation subtotal			**$37.27**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$1.12
	Monitoring - 1% of implementation costs	1	ls	$0.37
	Project Management - 15% of implementation costs	1	ls	$5.59
	Contingency - 15% of total costs	1	ls	$6.65
	Contractor Project Fees Subtotal			**$13.73**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 4			**$51.00**
2006	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 4			**$49.83**
	TOTAL COST PER ACRE, DEGRADED GRASSLANDS, YEAR 4			**$1,071.56**
2007	**Restoration enhancement planting:**			
	Airlift planting supplies to installation sites	1	ls	$17.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors	1	ls	$372.66
	Implementation subtotal			**$390.16**
	Containerized seedlings	500	seedlings	$143.75
	"Bio-Pak" (16-6-8 + minors) slow release fertilizer, 1 packet/seedling	500	packet	$7.50
	Pelletized compost - 1 pint/seedling	500	pint	$6.48
	"Treepro Junior" - 4"x12" plant protector, 1	500	protector	$57.50

8.8 Prescription: Degraded Grasslands

	Materials subtotal			**$215.23**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.70
	Monitoring - 1% of implementation costs	1	ls	$3.90
	Project Management - 15% of implementation costs	1	ls	$58.52
	Contractor's Margin - 10% of material costs	1	ls	$23.91
	Contingency - 15% of total costs	1	ls	$105.51
	Contractor Project Fees Subtotal			**$203.56**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 5			**$808.94**
2007	**Replacement plant installation:**			
	Airlift replanting supplies to installation sites - 20% of Year 4 airlift costs	1	ls	$3.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors - 20% of Year 4 planting	1	ls	$74.53
	Implementation subtotal			**$78.03**
	Replacement containerized seedlings - 20% of Year 3 totals	1	ls	$28.75
	Replacement plant proctectors and amendments	1	ls	$14.30
	Materials subtotal			**$43.05**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.34
	Monitoring - 1% of implementation costs	1	ls	$0.78
	Project Management - 15% of implementation costs	1	ls	$11.70
	Contractor's Margin - 10% of material costs	1	ls	$4.78
	Contingency - 15% of total costs	1	ls	$21.10
	Contractor Project Fees Subtotal			**$40.71**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 5			**$161.79**
2007	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Years 3 and 4 planting costs	1	ls	$74.53
	Implementation subtotal			**$74.53**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.24
	Monitoring - 1% of implementation costs	1	ls	$0.75
	Project Management - 15% of implementation costs	1	ls	$11.18
	Contingency - 15% of total costs	1	ls	$13.30
	Contractor Project Fees Subtotal			**$27.47**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 5			**$102.00**
2007	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 5			**$49.83**
	TOTAL COST PER ACRE, DEGRADED GRASSLANDS, YEAR 5			**$1,122.56**

8.8 Prescription: Degraded Grasslands

2008	**Restoration enhancement planting:**			
	Airlift planting supplies to installation sites	1	ls	$17.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors	1	ls	$372.66
	Implementation subtotal			**$390.16**
	Containerized seedlings	500	seedlings	$143.75
	"Bio-Pak" (16-6-8 + minors) slow release fertilizer, 1	500	packet	$7.50
	Pelletized compost - 1 pint/seedling	500	pint	$6.48
	"Treepro Junior" - 4"x12" plant protector, 1	500	protector	$57.50
	Materials subtotal			**$215.23**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.70
	Monitoring - 1% of implementation costs	1	ls	$3.90
	Project Management - 15% of implementation costs	1	ls	$58.52
	Contractor's Margin - 10% of material costs	1	ls	$23.91
	Contingency - 15% of total costs	1	ls	$105.51
	Contractor Project Fees Subtotal			**$203.56**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 6			**$808.94**
2008	**Replacement plant installation:**			
	Airlift replanting supplies to installation sites - 20% of Year 5 airlift costs	1	ls	$3.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors - 20% of Year 5 planting	1	ls	$74.53
	Implementation subtotal			**$78.03**
	Replacement containerized seedlings - 20% of Year 3 totals	1	ls	$28.75
	Replacement plant proctectors and amendments	1	ls	$14.30
	Materials subtotal			**$43.05**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.34
	Monitoring - 1% of implementation costs	1	ls	$0.78
	Project Management - 15% of implementation costs	1	ls	$11.70
	Contractor's Margin - 10% of material costs	1	ls	$4.78
	Contingency - 15% of total costs	1	ls	$21.10
	Contractor Project Fees Subtotal			**$40.71**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 6			**$161.79**
2008	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Years 4 and 5	1	ls	$74.53
	Implementation subtotal			**$74.53**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.24
	Monitoring - 1% of implementation costs	1	ls	$0.75
	Project Management - 15% of implementation costs	1	ls	$11.18
	Contingency - 15% of total costs	1	ls	$13.30
	Contractor Project Fees Subtotal			**$27.47**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 6			**$102.00**
2008	**Aerial application of fertilizer (maintenance rate):**			
	Aerial fertilization - dry application, maintenance rate	1	ls	$243.95
	Implementation subtotal			**$243.95**
	"Biosol Mix" (7-2-3) - organic fertilizer, maintenance rate	0.5	ton	$310.50
	Materials subtotal			**$310.50**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$7.32
	Monitoring - 1.5% of implementation costs	1	ls	$2.44
	Project Management - 15% of implementation costs	1	ls	$36.59
	Contractor's Margin - 10% of material costs	1	ls	$34.50

8.8 Prescription: Degraded Grasslands				
	Contingency - 15% of total costs	1	ls	$95.29
	Contractor Project Fees Subtotal			**$176.14**
	TOTAL COST PER ACRE, AERIAL APPLICATION OF FERTILIZER (MAINTENANCE RATE), YEAR 6			**$730.59**
2008	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 6			**$49.83**
	TOTAL COST PER ACRE, DEGRADED GRASSLANDS, YEAR 6			**$1,853.15**
2009	**Replacement plant installation:**			
	Airlift replanting supplies to installation sites - 20% of Year 6 airlift costs	1	ls	$3.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors - 20% of Year 6 planting	1	ls	$74.53
	Implementation subtotal			**$78.03**
	Replacement containerized seedlings - 20% of Year 3 totals	1	ls	$28.75
	Replacement plant proctectors and amendments	1	ls	$14.30
	Materials subtotal			**$43.05**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.34
	Monitoring - 1% of implementation costs	1	ls	$0.78
	Project Management - 15% of implementation costs	1	ls	$11.70
	Contractor's Margin - 10% of material costs	1	ls	$4.78
	Contingency - 15% of total costs	1	ls	$21.10
	Contractor Project Fees Subtotal			**$40.71**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 7			**$161.79**
2009	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Years 5 and 6 planting costs	1	ls	$74.53
	Implementation subtotal			**$74.53**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.24
	Monitoring - 1% of implementation costs	1	ls	$0.75
	Project Management - 15% of implementation costs	1	ls	$11.18
	Contingency - 15% of total costs	1	ls	$13.30
	Contractor Project Fees Subtotal			**$27.47**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 7			**$102.00**
2009	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**

8.8 Prescription: Degraded Grasslands				
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 7			**$49.83**
	TOTAL COST PER ACRE, DEGRADED GRASSLANDS, YEAR 7			**$313.61**
2010	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Years 6 and 7 planting costs	1	ls	$37.27
	Implementation subtotal			**$37.27**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$1.12
	Monitoring - 1% of implementation costs	1	ls	$0.37
	Project Management - 15% of implementation costs	1	ls	$5.59
	Contingency - 15% of total costs	1	ls	$6.65
	Contractor Project Fees Subtotal			**$13.73**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 8			**$51.00**
	TOTAL COST PER ACRE, DEGRADED GRASSLANDS, YEAR 8			**$51.00**
	TOTAL COST PER ACRE, DEGRADED GRASSLANDS (ACTIVE RESTORATION), ALL YEARS			**$22,268.25**
	TOTAL COST PER ACRE, DEGRADED GRASSLANDS (ACTIVE RESTORATION), ALL YEARS - NET PRESENT VALUE			**$18,963.94**

8.9 Prescription: Steep Slope Reclamation

Restoration Alternative: Active Restoration

Treatment Summary: Aerial application of agricultural lime; aerial application of fertilizer; restoration enhancement planting/replants; install/maintain tree protectorsnoxious weed control; restoration monitoring

Year	Treatment	Rate/acre	Unit	Cost/acre
2009	**Aerial application of agricultural lime:**			
	Aerial lime application	7.5	ton	$3,500.00
	Ground support - for aerial lime application	1	ls	$904.70
	Mobilization - for aerial lime application	1	ls	$82.25
	Implementation subtotal			**$4,486.95**
	Dolomitic lime	7.5	ton	$540.00
	"Soilmaster WR" - Polymer Tackifier	70	gallon	$420.00
	Materials subtotal			**$960.00**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$134.61
	Project Management - 15% of implementation costs	1	ls	$673.04
	Contractor's Margin - 10% of material costs	1	ls	$106.67
	Contingency - 15% of total costs	1	ls	$954.19
	Contractor Project Fees Subtotal			**$1,868.51**
	TOTAL COST PER ACRE, AERIAL APPLICATION OF AGRICULTURAL LIME, YEAR 1			**$7,315.46**
	TOTAL COST PER ACRE, STEEP SLOPE RECLAMATION, YEAR 1			**$7,315.46**
2010	**Aerial application of fertilizers - initial rate**			
	Aerial fertilization - dry application, initial rate	1	ls	$195.16
	Implementation subtotal			**$195.16**
	"Biosol Mix" (7-2-3) - organic fertilizer, initial rate	1	ton	$540.00
	Materials subtotal			**$540.00**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$5.85
	Project Management - 15% of implementation costs	1	ls	$29.27
	Contractor's Margin - 10% of material costs	1	ls	$60.00
	Contingency - 15% of total costs	1	ls	$124.54
	Contractor Project Fees Subtotal			**$219.67**
	TOTAL COST PER ACRE, AERIAL APPLICATION OF FERTILIZERS - INITIAL RATE,			**$954.83**
	TOTAL COST PER ACRE, STEEP SLOPE RECLAMATION, YEAR 2			**$954.83**
2011	**Restoration enhancement planting:**			
	Airlift planting supplies to installation sites	1	ls	$17.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors	1	ls	$372.66
	Implementation subtotal			**$390.16**
	Containerized seedlings	500	seedlings	$143.75
	"Bio-Pak" (16-6-8 + minors) slow release fertilizer, 1 packet/seedling	500	packet	$7.50
	Pelletized compost - 1 pint/seedling	500	pint	$6.48
	"Treepro Junior" - 4"x12" plant protector, 1	500	protector	$57.50
	Materials subtotal			**$215.23**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.70
	Monitoring - 1% of implementation costs	1	ls	$3.90
	Project Management - 15% of implementation costs	1	ls	$58.52
	Contractor's Margin - 10% of material costs	1	ls	$23.91
	Contingency - 15% of total costs	1	ls	$105.51
	Contractor Project Fees Subtotal			**$203.56**

8.9 Prescription: Steep Slope Reclamation

	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 3			**$808.94**
2011	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 3			**$49.83**
	TOTAL COST PER ACRE, STEEP SLOPE RECLAMATION, YEAR 3			**$858.77**
2012	**Restoration enhancement planting:**			
	Airlift planting supplies to installation sites	1	ls	$17.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors	1	ls	$372.66
	Implementation subtotal			**$390.16**
	Containerized seedlings	500	seedlings	$143.75
	"Bio-Pak" (16-6-8 + minors) slow release fertilizer, 1 packet/seedling	500	packet	$7.50
	Pelletized compost - 1 pint/seedling	500	pint	$6.48
	"Treepro Junior" - 4"x12" plant protector, 1	500	protector	$57.50
	Materials subtotal			**$215.23**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.70
	Monitoring - 1% of implementation costs	1	ls	$3.90
	Project Management - 15% of implementation costs	1	ls	$58.52
	Contractor's Margin - 10% of material costs	1	ls	$23.91
	Contingency - 15% of total costs	1	ls	$105.51
	Contractor Project Fees Subtotal			**$203.56**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 4			**$808.94**
2012	**Replacement plant installation:**			
	Airlift replanting supplies to installation sites - 20% of Year 3 airlift costs	1	ls	$3.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors - 20% of Year 3 planting	1	ls	$74.53
	Implementation subtotal			**$78.03**
	Replacement containerized seedlings - 20% of Year 3 totals	1	ls	$28.75
	Replacement plant proctectors and amendments	1	ls	$14.30
	Materials subtotal			**$43.05**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.34
	Monitoring - 1% of implementation costs	1	ls	$0.78
	Project Management - 15% of implementation costs	1	ls	$11.70
	Contractor's Margin - 10% of material costs	1	ls	$4.78
	Contingency - 15% of total costs	1	ls	$21.10
	Contractor Project Fees Subtotal			**$40.71**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 4			**$161.79**

8.9 Prescription: Steep Slope Reclamation

2012	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Year 3 planting costs	1	ls	$37.27
	Implementation subtotal			**$37.27**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$1.12
	Monitoring - 1% of implementation costs	1	ls	$0.37
	Project Management - 15% of implementation costs	1	ls	$5.59
	Contingency - 15% of total costs	1	ls	$6.65
	Contractor Project Fees Subtotal			**$13.73**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 4			**$51.00**
2012	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 4			**$49.83**
	TOTAL COST PER ACRE, STEEP SLOPE RECLAMATION, YEAR 4			**$1,071.56**
2013	**Restoration enhancement planting:**			
	Airlift planting supplies to installation sites	1	ls	$17.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors	1	ls	$372.66
	Implementation subtotal			**$390.16**
	Containerized seedlings	500	seedlings	$143.75
	"Bio-Pak" (16-6-8 + minors) slow release fertilizer, 1 packet/seedling	500	packet	$7.50
	Pelletized compost - 1 pint/seedling	500	pint	$6.48
	"Treepro Junior" - 4"x12" plant protector, 1	500	protector	$57.50
	Materials subtotal			**$215.23**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.70
	Monitoring - 1% of implementation costs	1	ls	$3.90
	Project Management - 15% of implementation costs	1	ls	$58.52
	Contractor's Margin - 10% of material costs	1	ls	$23.91
	Contingency - 15% of total costs	1	ls	$105.51
	Contractor Project Fees Subtotal			**$203.56**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 5			**$808.94**
2013	**Replacement plant installation:**			
	Airlift replanting supplies to installation sites - 20% of Year 4 airlift costs	1	ls	$3.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors - 20% of Year 4 planting	1	ls	$74.53
	Implementation subtotal			**$78.03**
	Replacement containerized seedlings - 20% of Year 3 totals	1	ls	$28.75

8.9 Prescription: Steep Slope Reclamation

	Replacement plant proctectors and amendments	1	ls	$14.30
	Materials subtotal			**$43.05**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.34
	Monitoring - 1% of implementation costs	1	ls	$0.78
	Project Management - 15% of implementation costs	1	ls	$11.70
	Contractor's Margin - 10% of material costs	1	ls	$4.78
	Contingency - 15% of total costs	1	ls	$21.10
	Contractor Project Fees Subtotal			**$40.71**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 5			**$161.79**
2013	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Years 3 and 4 planting costs	1	ls	$74.53
	Implementation subtotal			**$74.53**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.24
	Monitoring - 1% of implementation costs	1	ls	$0.75
	Project Management - 15% of implementation costs	1	ls	$11.18
	Contingency - 15% of total costs	1	ls	$13.30
	Contractor Project Fees Subtotal			**$27.47**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 5			**$102.00**
2013	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 5			**$49.83**
	TOTAL COST PER ACRE, STEEP SLOPE RECLAMATION, YEAR 5			**$1,122.56**
2014	**Restoration enhancement planting:**			
	Airlift planting supplies to installation sites	1	ls	$17.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors	1	ls	$372.66
	Implementation subtotal			**$390.16**
	Containerized seedlings	500	seedlings	$143.75
	"Bio-Pak" (16-6-8 + minors) slow release fertilizer, 1	500	packet	$7.50
	Pelletized compost - 1 pint/seedling	500	pint	$6.48
	"Treepro Junior" - 4"x12" plant protector, 1	500	protector	$57.50
	Materials subtotal			**$215.23**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.70
	Monitoring - 1% of implementation costs	1	ls	$3.90
	Project Management - 15% of implementation costs	1	ls	$58.52
	Contractor's Margin - 10% of material costs	1	ls	$23.91
	Contingency - 15% of total costs	1	ls	$105.51
	Contractor Project Fees Subtotal			**$203.56**

8.9 Prescription: Steep Slope Reclamation

	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 6			**$808.94**
2014	**Replacement plant installation:**			
	Airlift replanting supplies to installation sites - 20% of Year 5 airlift costs	1	ls	$3.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors - 20% of Year 5 planting	1	ls	$74.53
	Implementation subtotal			**$78.03**
	Replacement containerized seedlings - 20% of Year 3 totals	1	ls	$28.75
	Replacement plant proctectors and amendments	1	ls	$14.30
	Materials subtotal			**$43.05**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.34
	Monitoring - 1% of implementation costs	1	ls	$0.78
	Project Management - 15% of implementation costs	1	ls	$11.70
	Contractor's Margin - 10% of material costs	1	ls	$4.78
	Contingency - 15% of total costs	1	ls	$21.10
	Contractor Project Fees Subtotal			**$40.71**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 6			**$161.79**
2014	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Years 4 and 5 planting costs	1	ls	$74.53
	Implementation subtotal			**$74.53**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.24
	Monitoring - 1% of implementation costs	1	ls	$0.75
	Project Management - 15% of implementation costs	1	ls	$11.18
	Contingency - 15% of total costs	1	ls	$13.30
	Contractor Project Fees Subtotal			**$27.47**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 6			**$102.00**
2014	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 6			**$49.83**
	TOTAL COST PER ACRE, STEEP SLOPE RECLAMATION, YEAR 6			**$1,122.56**
2015	**Replacement plant installation:**			
	Airlift replanting supplies to installation sites - 20% of Year 6 airlift costs	1	ls	$3.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors - 20% of Year 6 planting	1	ls	$74.53
	Implementation subtotal			**$78.03**
	Replacement containerized seedlings - 20% of Year 3 totals	1	ls	$28.75

8.9 Prescription: Steep Slope Reclamation				
	Replacement plant proctectors and amendments	1	ls	$14.30
	Materials subtotal			**$43.05**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.34
	Monitoring - 1% of implementation costs	1	ls	$0.78
	Project Management - 15% of implementation costs	1	ls	$11.70
	Contractor's Margin - 10% of material costs	1	ls	$4.78
	Contingency - 15% of total costs	1	ls	$21.10
	Contractor Project Fees Subtotal			**$40.71**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 7			**$161.79**
2015	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Years 5 and 6 planting costs	1	ls	$74.53
	Implementation subtotal			**$74.53**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.24
	Monitoring - 1% of implementation costs	1	ls	$0.75
	Project Management - 15% of implementation costs	1	ls	$11.18
	Contingency - 15% of total costs	1	ls	$13.30
	Contractor Project Fees Subtotal			**$27.47**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 7			**$102.00**
2015	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 7			**$49.83**
	TOTAL COST PER ACRE, STEEP SLOPE RECLAMATION, YEAR 7			**$313.61**
2016	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Years 6 and 7 planting costs	1	ls	$37.27
	Implementation subtotal			**$37.27**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$1.12
	Monitoring - 1% of implementation costs	1	ls	$0.37
	Project Management - 15% of implementation costs	1	ls	$5.59
	Contingency - 15% of total costs	1	ls	$6.65
	Contractor Project Fees Subtotal			**$13.73**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 8			**$51.00**
	TOTAL COST PER ACRE, STEEP SLOPE RECLAMATION, YEAR 8			**$51.00**
	TOTAL COST PER ACRE, STEEP SLOPE RECLAMATION (ACTIVE RESTORATION), ALL YEARS			**$12,810.34**

8.9 Prescription: Steep Slope Reclamation	
TOTAL COST PER ACRE, STEEP SLOPE RECLAMATION (ACTIVE RESTORATION), ALL YEARS - NET PRESENT VALUE	$8,969.69

8.10 Prescription: Impacted Grasslands

Restoration Alternative: Active Restoration

Treatment Summary: Restoration enhancement planting/replants; install/maintain tree protectors; noxious

Year	Treatment	Rate/acre	Unit	Cost/acre
2003	TOTAL COST PER ACRE, IMPACTED GRASSLANDS, YEAR 1			$0.00
2004	TOTAL COST PER ACRE, IMPACTED GRASSLANDS, YEAR 2			$0.00
2005	**Restoration enhancement planting:**			
	Airlift planting supplies to installation sites	1	ls	$17.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors	1	ls	$372.66
	Implementation subtotal			**$390.16**
	Containerized seedlings	500	seedlings	$143.75
	"Bio-Pak" (16-6-8 + minors) slow release fertilizer, 1 packet/seedling	500	packet	$7.50
	Pelletized compost - 1 pint/seedling	500	pint	$6.48
	"Treepro Junior" - 4"x12" plant protector, 1	500	protector	$57.50
	Materials subtotal			**$215.23**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.70
	Monitoring - 1% of implementation costs	1	ls	$3.90
	Project Management - 15% of implementation costs	1	ls	$58.52
	Contractor's Margin - 10% of material costs	1	ls	$23.91
	Contingency - 15% of total costs	1	ls	$105.51
	Contractor Project Fees Subtotal			**$203.56**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 3			**$808.94**
2005	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 3			**$49.83**
	TOTAL COST PER ACRE, IMPACTED GRASSLANDS, YEAR 3			**$858.77**
2006	**Restoration enhancement planting:**			
	Airlift planting supplies to installation sites	1	ls	$17.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors	1	ls	$372.66
	Implementation subtotal			**$390.16**
	Containerized seedlings	500	seedlings	$143.75
	"Bio-Pak" (16-6-8 + minors) slow release fertilizer, 1 packet/seedling	500	packet	$7.50
	Pelletized compost - 1 pint/seedling	500	pint	$6.48
	"Treepro Junior" - 4"x12" plant protector, 1	500	protector	$57.50
	Materials subtotal			**$215.23**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.70

8.10 Prescription: Impacted Grasslands

	Monitoring - 1% of implementation costs	1	ls	$3.90
	Project Management - 15% of implementation costs	1	ls	$58.52
	Contractor's Margin - 10% of material costs	1	ls	$23.91
	Contingency - 15% of total costs	1	ls	$105.51
	Contractor Project Fees Subtotal			**$203.56**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 4			**$808.94**
2006	**Replacement plant installation:**			
	Airlift replanting supplies to installation sites - 20% of Year 3 airlift costs	1	ls	$3.50
	Plant seedlings - includes mobilization, planting,	1	ls	$74.53
	Implementation subtotal			**$78.03**
	Replacement containerized seedlings - 20% of Year 3 totals	1	ls	$28.75
	Replacement plant proctectors and amendments	1	ls	$14.30
	Materials subtotal			**$43.05**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.34
	Monitoring - 1% of implementation costs	1	ls	$0.78
	Project Management - 15% of implementation costs	1	ls	$11.70
	Contractor's Margin - 10% of material costs	1	ls	$4.78
	Contingency - 15% of total costs	1	ls	$21.10
	Contractor Project Fees Subtotal			**$40.71**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 4			**$161.79**
2006	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Year 3 planting costs	1	ls	$37.27
	Implementation subtotal			**$37.27**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$1.12
	Monitoring - 1% of implementation costs	1	ls	$0.37
	Project Management - 15% of implementation costs	1	ls	$5.59
	Contingency - 15% of total costs	1	ls	$6.65
	Contractor Project Fees Subtotal			**$13.73**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 4			**$51.00**
2006	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 4			**$49.83**
	TOTAL COST PER ACRE, IMPACTED GRASSLANDS, YEAR 4			**$1,071.56**
2007	**Restoration enhancement planting:**			
	Airlift planting supplies to installation sites	1	ls	$17.50

8.10 Prescription: Impacted Grasslands				
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors	1	ls	$372.66
	Implementation subtotal			**$390.16**
	Containerized seedlings	500	seedlings	$143.75
	"Bio-Pak" (16-6-8 + minors) slow release fertilizer, 1	500	packet	$7.50
	Pelletized compost - 1 pint/seedling	500	pint	$6.48
	"Treepro Junior" - 4"x12" plant protector, 1	500	protector	$57.50
	Materials subtotal			**$215.23**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.70
	Monitoring - 1% of implementation costs	1	ls	$3.90
	Project Management - 15% of implementation costs	1	ls	$58.52
	Contractor's Margin - 10% of material costs	1	ls	$23.91
	Contingency - 15% of total costs	1	ls	$105.51
	Contractor Project Fees Subtotal			**$203.56**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 5			**$808.94**
2007	**Replacement plant installation:**			
	Airlift replanting supplies to installation sites - 20% of Year 4 airlift costs	1	ls	$3.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors - 20% of Year 4 planting	1	ls	$74.53
	Implementation subtotal			**$78.03**
	Replacement containerized seedlings - 20% of Year 3 totals	1	ls	$28.75
	Replacement plant proctectors and amendments	1	ls	$14.30
	Materials subtotal			**$43.05**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.34
	Monitoring - 1% of implementation costs	1	ls	$0.78
	Project Management - 15% of implementation costs	1	ls	$11.70
	Contractor's Margin - 10% of material costs	1	ls	$4.78
	Contingency - 15% of total costs	1	ls	$21.10
	Contractor Project Fees Subtotal			**$40.71**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 5			**$161.79**
2007	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Years 3 and 4 planting costs	1	ls	$74.53
	Implementation subtotal			**$74.53**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.24
	Monitoring - 1% of implementation costs	1	ls	$0.75
	Project Management - 15% of implementation costs	1	ls	$11.18
	Contingency - 15% of total costs	1	ls	$13.30
	Contractor Project Fees Subtotal			**$27.47**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 5			**$102.00**
2007	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11

8.10 Prescription: Impacted Grasslands				
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 5			**$49.83**
	TOTAL COST PER ACRE, IMPACTED GRASSLANDS, YEAR 5			**$1,122.56**
2008	**Restoration enhancement planting:**			
	Airlift planting supplies to installation sites	1	ls	$17.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors	1	ls	$372.66
	Implementation subtotal			**$390.16**
	Containerized seedlings	500	seedlings	$143.75
	"Bio-Pak" (16-6-8 + minors) slow release fertilizer, 1	500	packet	$7.50
	Pelletized compost - 1 pint/seedling	500	pint	$6.48
	"Treepro Junior" - 4"x12" plant protector, 1	500	protector	$57.50
	Materials subtotal			**$215.23**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$11.70
	Monitoring - 1% of implementation costs	1	ls	$3.90
	Project Management - 15% of implementation costs	1	ls	$58.52
	Contractor's Margin - 10% of material costs	1	ls	$23.91
	Contingency - 15% of total costs	1	ls	$105.51
	Contractor Project Fees Subtotal			**$203.56**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 6			**$808.94**
2008	**Replacement plant installation:**			
	Airlift replanting supplies to installation sites - 20% of Year 5 airlift costs	1	ls	$3.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors - 20% of Year 5 planting	1	ls	$74.53
	Implementation subtotal			**$78.03**
	Replacement containerized seedlings - 20% of Year 3 totals	1	ls	$28.75
	Replacement plant proctectors and amendments	1	ls	$14.30
	Materials subtotal			**$43.05**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.34
	Monitoring - 1% of implementation costs	1	ls	$0.78
	Project Management - 15% of implementation costs	1	ls	$11.70
	Contractor's Margin - 10% of material costs	1	ls	$4.78
	Contingency - 15% of total costs	1	ls	$21.10
	Contractor Project Fees Subtotal			**$40.71**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 6			**$161.79**
2008	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Years 4 and 5 planting costs	1	ls	$74.53
	Implementation subtotal			**$74.53**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.24
	Monitoring - 1% of implementation costs	1	ls	$0.75
	Project Management - 15% of implementation costs	1	ls	$11.18
	Contingency - 15% of total costs	1	ls	$13.30
	Contractor Project Fees Subtotal			**$27.47**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 6			**$102.00**
2008	**Noxious weed control:**			

8.10 Prescription: Impacted Grasslands				
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 6			**$49.83**
	TOTAL COST PER ACRE, IMPACTED GRASSLANDS, YEAR 6			**$1,122.56**
2009	**Replacement plant installation:**			
	Airlift replanting supplies to installation sites - 20% of Year 6 airlift costs	1	ls	$3.50
	Plant seedlings - includes mobilization, planting, amendments, and tree protectors - 20% of Year 6 planting	1	ls	$74.53
	Implementation subtotal			**$78.03**
	Replacement containerized seedlings - 20% of Year 3 totals	1	ls	$28.75
	Replacement plant proctectors and amendments	1	ls	$14.30
	Materials subtotal			**$43.05**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.34
	Monitoring - 1% of implementation costs	1	ls	$0.78
	Project Management - 15% of implementation costs	1	ls	$11.70
	Contractor's Margin - 10% of material costs	1	ls	$4.78
	Contingency - 15% of total costs	1	ls	$21.10
	Contractor Project Fees Subtotal			**$40.71**
	TOTAL COST PER ACRE, RESTORATION ENHANCEMENT PLANTING, YEAR 7			**$161.79**
2009	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Years 5 and 6 planting costs	1	ls	$74.53
	Implementation subtotal			**$74.53**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$2.24
	Monitoring - 1% of implementation costs	1	ls	$0.75
	Project Management - 15% of implementation costs	1	ls	$11.18
	Contingency - 15% of total costs	1	ls	$13.30
	Contractor Project Fees Subtotal			**$27.47**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 7			**$102.00**
2009	**Noxious weed control:**			
	Release of beneficial insects for biological control of noxious weed species	1	ls	$10.30
	Implementation subtotal			**$10.30**
	Beneficial insects	27	carton	$27.96
	Materials subtotal			**$27.96**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$0.31
	Monitoring - 1% of implementation costs	1	ls	$0.10
	Project Management - 15% of implementation costs	1	ls	$1.55
	Contractor's Margin - 10% of material costs	1	ls	$3.11
	Contingency - 15% of total costs	1	ls	$6.50

8.10 Prescription: Impacted Grasslands				
	Contractor Project Fees Subtotal			**$11.56**
	TOTAL COST PER ACRE, NOXIOUS WEED CONTROL, YEAR 7			**$49.83**
	TOTAL COST PER ACRE, IMPACTED GRASSLANDS, YEAR 7			**$313.61**
2010	**Maintenance of plant protectors:**			
	Maintenance of plant protectors - 10% of Years 6 and 7 planting costs	1	ls	$37.27
	Implementation subtotal			**$37.27**
	Project Design and Work Plan - 3% of implementation costs	1	ls	$1.12
	Monitoring - 1% of implementation costs	1	ls	$0.37
	Project Management - 15% of implementation costs	1	ls	$5.59
	Contingency - 15% of total costs	1	ls	$6.65
	Contractor Project Fees Subtotal			**$13.73**
	TOTAL COST PER ACRE, MAINTENANCE OF PLANT PROTECTORS, YEAR 8			**$51.00**
	TOTAL COST PER ACRE, IMPACTED GRASSLANDS, YEAR 8			**$51.00**
	TOTAL COST PER ACRE, IMPACTED GRASSLANDS (ACTIVE RESTORATION), ALL YEARS			**$4,540.05**
	TOTAL COST PER ACRE, IMPACTED GRASSLANDS (ACTIVE RESTORATION), ALL YEARS - NET PRESENT VALUE			**$3,595.84**

APPENDIX A

COMMON AND LATIN NAMES OF PLANT SPECIES

Appendix A: Common and Latin Names of Plant Species

Common Name	*Latin Name*
Alfalfa	*Medicago sativa*
Antelope Bitterbrush	*Purshia tridentata*
Antennaria	*Antennaria racemosa*
Arnica	*Arnica sp.*
Arrowleaf Balsamroot	*Balsamorhiza sagittata*
Aster	*Aster conspicuus*
Basin Wildrye	*Elymus cinereus*
Bearberry	*Arctostaphylos uva-ursi*
Beargrass	*Xerophyllum tenax*
Bebb's Willow	*Salix bebbiana*
Bent Grass	*Agrostis spp*
Besseya, Wyoming Kittentails	*Besseya wyomingensis*
Big sagebrush	*Artemisia tridentata*
Biscuitroot	*Lomatium triternatum*
Black Cottonwood	*Populus trichocarpa*
Black Twinberry	*Lonicera involucrata*
Blue Flax	*Linum lewisii*
Bluebunch Wheatgrass	*Agropyron spicatum*
Bluegrass	*Poa spp.*
Bottlebrush Squirreltail	*Sitanion hystrix*
Canada Thistle	*Cirsium arvense*
Carex	*Carex spp.*
Chrysopsis	*Chrysopsis Villosa*
Common Chokecherry	*Prunus virginiana*
Common Juniper	*Juniperus communis*
Cranesbill	*Geranium viscosissimum*
Creeping Juniper	*Juniperus horizontalis*
Current, Gooseberry	*Ribes spp.*
Douglas Fir	*Pseudotsuga menziesii*
Downy Brome	*Bromus tectorum*
Dwarf Huckleberry	*Vaccinium caespitosum*
Elk Sedge	*Carex geyeri*
Engelmann Spruce	*Picea engelmannii*
False Solomon's Seal	*Smilacina racemosa*
Field Chickweed	*Cerastium arvense*
Fireweed	*Epilobium angustifolium*
Globe Huckleberry	*Vaccinium globulare*
Goatsbeard	*Tragopogon dubious*
Gooseberry	*Ribes spp.*
Graceful Cinquefoil	*Potentilla gracilis*
Grand Fir	*Abies grandis*
Green Rabbitbrush	*Chrysothamnus viscidiflorus*
Grouse Whortleberry	*Vaccinium scoparium*
Hairy Golden Aster	*Chrysopsis Villosa*

Hairy Vetch	*Vicia villosa*
Harebell	*Campanula rotundifolia*
Heartleaf Arnica	*Arnica cordifolia*
Hood's Phlox	*Phlox hoodii*
Horizontal Juniper	*Juniperus horizontalis*
Horsebrush	*Tetradymia canescens*
Idaho Fescue	*Festuca idahoensis*
Indian Paint Brush	*Castilleja lutescens*
Japanese Brome	*Bromus japonicus*
Juncus	*Juncus spp.*
Lacy Phacelia	*Phacelia tanacetifolia*
Leafy Spurge	*Euphorbia esula*
Limber Pine	*Pinus flexilis*
Lodgepole Pine	*Pinus contorta*
Lupine	*Lupinus argenteus*
Mallow Ninebark	*Physocarpus malvaceus*
Menziesia	*Menziesia ferruginea*
Mountain Arnica	*Arnica latifolia*
Mountain Hemlock	*Tsuga mertensiana*
Mountain Strawberry	*Fragaria virginiana*
Mountain Sweet-cicely	*Osmorhiza chilensis*
Needle & Thread	*Stipa comata*
Nine-leaf Lomatium	*Lomatium triternatum*
Northern Bedstraw	*Galium boreale*
Northwest Cinquefoil	*Potentilla gracilis*
Old Man's Whiskers	*Geum triflorum*
Oregon Grape	*Berberis repens*
Pinegrass	*Calamagrostis rubescens*
Poa	*Poa spp.*
Ponderosa Pine	*Pinus ponderosa*
Prairie Junegrass	*Koelaria cristata*
Prairie Sage	*Artemisia ludoviciana*
Prairiesmoke	*Geum triflorum*
Pyrola	*Pyrola secunda*
Quaking Aspen	*Populus tremuloides*
Raceme Pussy-toes	*Antennaria racemosa*
Rocky Mountain Juniper	*Juniperus scopulorum*
Rocky Mountain Maple	*Acer glabrum*
Rocky Mountain Penstemon	*Penstemon strictus*
Rosy Pussy-toes	*Antennaria rosea*
Rough Fescue	*Festuca scabrella*
Round-leaved Violet	*Viola orbiculata*
Rubber Rabbitbrush	*Chrysothamnus nauseosus*
Rush	*Juncus spp.*
Russet Buffaloberry	*Shepherdia canadensis*
Sandberg Bluegrass	*Poa sandbergii (Poa secunda)*
Scouler's Willow	*Salix scouleriana*
Sedge	*Carex spp.*

Serviceberry	*Amelanchier alnifolia*
Sheep Fescue	*Festuca ovina*
Showy Aster	*Aster conspicuus*
Silky Lupine	*Lupinus sericeus*
Silvery Lupine	*Lupinus argenteus*
Sitka Alder	*Alnus sinuata*
Smooth Woodrush	*Luzula hitchcockii*
Snowberry	*Symphoricarpos albus*
Spotted Knapweed	*Centaurea maculosa*
Stoneseed	*Lithospermum ruderale*
Subalpine Fir	*Abies lasiocarpa*
Tall Kittentails	*Besseya wyomingensis*
Tufted Hairgrass	*Deschampsia cespitosa*
Twinflower	*Linnaea borealis*
Western Hemlock	*Tsuga heterophylla*
Western Larch	*Larix occidentalis*
Western Meadowrue	*Thalictrum occidentale*
Western Needlegrass	*Stipa occidentalis*
Western Red Cedar	*Thuja plicata*
Western Salsify	*Tragopogon dubious*
White Fir	*Abies concolor*
White Spirea	*Spirea betulifolia*
Winterfat	*Ceratoides lanata*
Wintergreen, Shinleaf	*Pyrola secunda*
Woods Rose	*Rosa woodsii*
Yarrow, Milfoil	*Achillea millefolium*

APPENDIX B

CHARACTERISTIC BIRDS AND MAMMALS OF SOUTHWESTERN MONTANA

Appendix B: Characteristic Birds and Mammals of Southwestern Montana

Source: (Montana 1995)

Bird Species	
Red-tailed hawk	*Buteo jamaicensis*
Sharp-shinned hawk	*Accipiter striatus*
Cooper's hawk	*Accipiter cooperii*
Northern goshawk	*Accipiter gentilis*
Blue grouse	*Dendragapus obscurus*
Spruce grouse	*Dendragapus canadensis*
Northern saw-whet owl	*Aegolius acadicus*
Downy woodpecker	*Picoides pubescens*
Hairy woodpecker	*Picoides villosus*
Olive-sided flycatcher	*Contopus borealis*
Western wood-pewee	*Contopus sordidulus*
Grey jay	*Perisoreus canadensis*
Steller's jay	*Cyanocitta stelleri*
Clark's nutcracker	*Nucifraga columbiana*
Mountain chickadee	*Parus gambeli*
Red-breasted nuthatch	*Sitta canadensis*
House wren	*Troglodytes aedon*
Ruby-crowned kinglet	*Regulus calendula*
Mountain bluebird	*Sialia currucoides*
Townsend's solitaire	*Myadestes townsedii*
Swainson's thrush	*Catharus guttatus*
American robin	*Turdus migratorius*
Cedar waxwing	*Bombycilla cedrorum*
Yellow-rumped warbler	*Dendroica coronata*
Western tanager	*Piranga ludoviciana*
Chipping sparrow	*Spizella passerina*
White-crowned sparrow	*Zonotrichia leucophrys*
Dark-eyed junco	*Junco hyemalis*
Pine grosbeak	*Pinicola enucleator*
Red crossbill	*Loxia curvirostra*
Pine siskin	*Carduelis pinus*
Evening gosbeak	*Coccothraustes vespertinus*

Mammal Species	
Snowshoe hare	*Lepus americanus*
Red squirrel	*Tamiasciurus hudsonicus*
Porcupine	*Erithezon dorsatum*
Black bear	*Ursus americanus*
Pine marten	*Martes americana*
Ermine	*Mustella erminea*
Mountain lion	*Felis concolor*
Bobcat	*Felis rufus*
Lynx	*Felis lynx*
Elk	*Cervus elaphus*

APPENDIX C

DATA SOURCES

Appendix C: Data Sources

1: Field Data for Anaconda Uplands Injured Areas (2000) formatted as compact disk (CD).
  a) 01/02/02a. Reference Area Data as Excel Spreadsheet.
  b) 01/02/02b. Mount Haggin Field Data as Excel Spreadsheet.

2: Photographic Data for Anaconda Uplands Injured Area Spring/Summer 2000/2001. Submitted in supplemental binder.